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Factors Influencing a Declining Pronghorn Population in Wind Cave National Park, South Dakota

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FACTORS INFLUENCING A DECLINING PRONGHORN POPULATION IN WIND CAVE NATIONAL PARK, SOUTH DAKOTA

BY

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This thesis is approved as a creditable and independent investigation by a candidate for the Master of Science degree and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that conclusions reached by the candidate are necessarily the conclusions of the major department.

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ABSTRACT

FACTORS INFLUENCING A DECLINING PRONGHORN POPULATION IN WIND CAVE NATIONAL PARK, SOUTH DAKOTA

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Pronghorn (*Antilocapra americana*) were reintroduced into Wind Cave National Park (WCNP) in 1914 and thus, have inhabited the park for almost a century. A decline in the population has raised concern for the continued existence of pronghorn inside the park. Historically, pronghorn numbers reached greater than 300 individuals but were estimated to be less than 50 individuals during this study. Knowledge of food habits, genetic structure, causes of mortality, survival rates, and information related to movements were important to developing an understanding of factors contributing to this decline. Past studies have described spatial relationships and breeding behavior of adults and survival strategies of neonates. However, direct information was not available on the recent decline of pronghorn in WCNP. The primary objectives of this study were to identify factors contributing to the decline of pronghorn in WCNP with regard to movements, mortality (e.g., predation), diet quality, and genetic variation. A secondary objective was to identify characteristics of daytime bed sites used by pronghorn neonates during the first three weeks of life. Radio telemetry was used to monitor the movements

and mortality of 8 adult (>1 year at capture) and 19 neonate (< 1 month at capture) pronghorn from 26 January 2002 to 31 May 2004. During the study, visual locations were obtained on 8 adult females (*n*=407), 3 adult males (*n*=177), and 19 neonates (*n*=148). Mean daily distance traveled by radiocollared females was 2.6 km (*n*=8) in winter and 2.5 km (*n*=8) in summer. Ninety-five percent home range contours calculated for radiocollared females were 66.6 km^2 (*n*=8) during winter and 54.5 km^2 (*n*=8) during summer. Fifty percent core use contours were 7.2 km^2 (*n*=8) during winter and 7.3 km^2 (*n*=8) during summer. The longest summer movement of a radiocollared adult female was 11.5 km, and the longest winter movement was 11.0 km. Survival of adult female pronghorn was 87.5% in 2002 and 85.7% in 2003. Predation accounted for all adult pronghorn deaths during the study. Survival of pronghorn neonates was 22.2% in 2002 and 41.7% in 2003. Coyotes (*Canis latrans*) accounted for 50% of fawn deaths and likely contributed to mortalities of neonates from unknown predators. Fifty daytime fawn bed sites and 50 random sites were sampled in June of 2002 and 2003. Height of vegetation surrounding bed sites was not significantly different from random sites in 2002 (*P*=0.959). However, significant differences were observed in height of vegetation between bed sites and random sites in 2003 (*P*=0.059). Microhistological fecal analysis was conducted on 58 samples collected from pronghorn in 2002. Blue grama (*Bouteloua gracilis*), common juniper (*Juniperus communis*), and northern bedstraw (*Galium boreale*) were identified as important seasonal food items, representing 14.6, 10.6, and 6.5% of the annual diet, respectively. Annual diets of pronghorn in WCNP included 41.5% grasses, 31.1% shrubs, and 27.4% forbs. Microsatellite DNA collected from 75

pronghorn in WCNP (*n*=11), Harding County (*n*=33), and Fall River County (*n*=31), South Dakota, showed similar levels of observed heterozygosity (0.473 to 0.594) and low inbreeding coefficients (-0.168 to 0.037). These results indicated that fawn mortality and availability of forage were significant factors limiting population growth in pronghorn within WCNP during this study.

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CHAPTER 1

INTRODUCTION

BACKGROUND

Movement patterns, food habits, and survival of pronghorn (*Antilocapra americana*) have been described for free-ranging populations throughout western North America. Less is known about population dynamics of pronghorn populations within enclosed systems. Wind Cave National Park (WCNP), South Dakota, has maintained a pronghorn population within its boundaries since 1914. A decline in the population has raised concern for the continued existence of pronghorn inside the park. During the 1960's, pronghorn numbers increased to over 300 individuals (WCNP, unpublished data) but were estimated at less than 30 individuals in 2002. Past studies have described the social behavior of pronghorn adults and neonates in WCNP (Bromley 1977, McDonald 1987, Maher 2000). However, current information regarding movements, dietary composition, genetic variation, and survival of pronghorn within the park has not been collected.

JUSTIFICATION

The mission of the National Park Service includes the responsibility to preserve and protect the wildlife resources that exist within parks. Therefore, maintaining a healthy pronghorn herd in WCNP is of importance. Also, previous studies have not focused on the decline of pronghorn within the park. Movement by pronghorn out of WCNP over snow-filled cattle guards has been observed during severe winters. However, the frequency of these movements and the number of pronghorn leaving WCNP was not known. Current information regarding survival rates, causes of

mortality, food habits, and genetic heterozygosity would provide the basis for developing future management strategies and would identify potential factors contributing to the decline of the pronghorn population in WCNP.

OBJECTIVES

This study was conducted from 24 January 2002 to 31 May 2004. The primary objectives of this study were to identify factors contributing to the decline of pronghorn in WCNP with regard to movements, mortality, diet quality, and genetic variation. A secondary objective was to document vegetative characteristics at daytime bed sites used by pronghorn neonates during the first 3 weeks of life. Methods of this study were approved by the South Dakota State University Institutional Animal Care and Use Committee (Approval Number 02-A002).

STUDY AREA

The study area was located in WCNP in the Black Hills of South Dakota (Figure 1). The Black Hills are an isolated mountain range located in southwestern South Dakota and northeastern Wyoming and encompasses about 8400 km^2 (Fecske and Jenks 2002). Wind Cave National Park encompassed an area of 115 km^2, with an average elevation of 1257 m above mean sea level and is situated in the southeast region of the Black Hills. The study area was enclosed by a 2.5 m woven-wire fence, with cattle guards present at all road entrances to prevent movement by ungulates out of the park.

The landscape was a mixture of mixed-grass prairie interspersed with a ponderosa pine (*Pinus ponderosa*) dominated forest. Several grassland regions within WCNP were

associated with pronghorn during this study (Figure 2). Plant species occurring in the mixed-grass prairie within WCNP included Kentucky bluegrass (*Poa pratensis*), blue grama (*Bouteloua gracilis*), western wheatgrass (*Pascopyrum smithii*), western snowberry (*Symphoricarpos occidentalis*), common juniper (*Juniperus communis*), and northern bedstraw (*Galium boreale*). Wildlife resources existing within the park included bison (*Bison bison*), elk (*Cervus elaphus*), pronghorn, white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), and prairie dogs (*Cynomys ludovicianus*). Badgers (*Taxidea taxus*), thirteen-lined ground squirrels (*Citellus tridecemlineatus*), porcupines (*Erethizon dorsatum*), and eastern cottontails (*Sylvilagus floridanus*) represented some of the small mammals that existed within WCNP during this study (Duckwitz 2001). Numerous species of raptors, upland birds, and songbirds existed in WCNP including sharp-tailed grouse (*Tympanuchus phasianellus*), burrowing owls (*Athene cunicularia*), dark-eyed juncos (*Junco hyemalis*) and western meadowlarks (*Sturnella neglecta*). Predators of pronghorn that existed within WCNP included coyotes (*Canis latrans*), bobcats (*Lynx rufus*), mountain lions (*Puma concolor*) and golden eagles (*Aquila chrysaetos*). Temperatures ranged from 24˚C to -18˚C during the winter of 2002 (South Dakota Office of Climatology 2004). During the summer of 2002, temperatures ranged from 32˚C to -10˚C (South Dakota Office of Climatology 2004). Monthly precipitation during 2002 ranged from 7.4 to 0.1 cm during winter, while precipitation during summer months ranged from 6.5 to 2.3 cm (South Dakota Office of Climatology 2004).

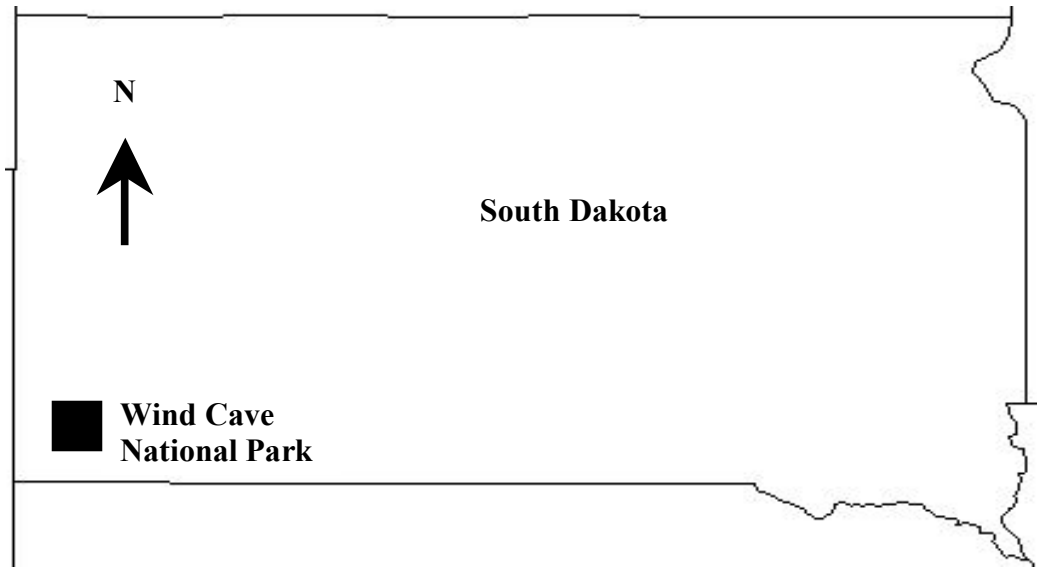


Figure 1. Location of Wind Cave National Park in southwestern South Dakota, 2002-03.

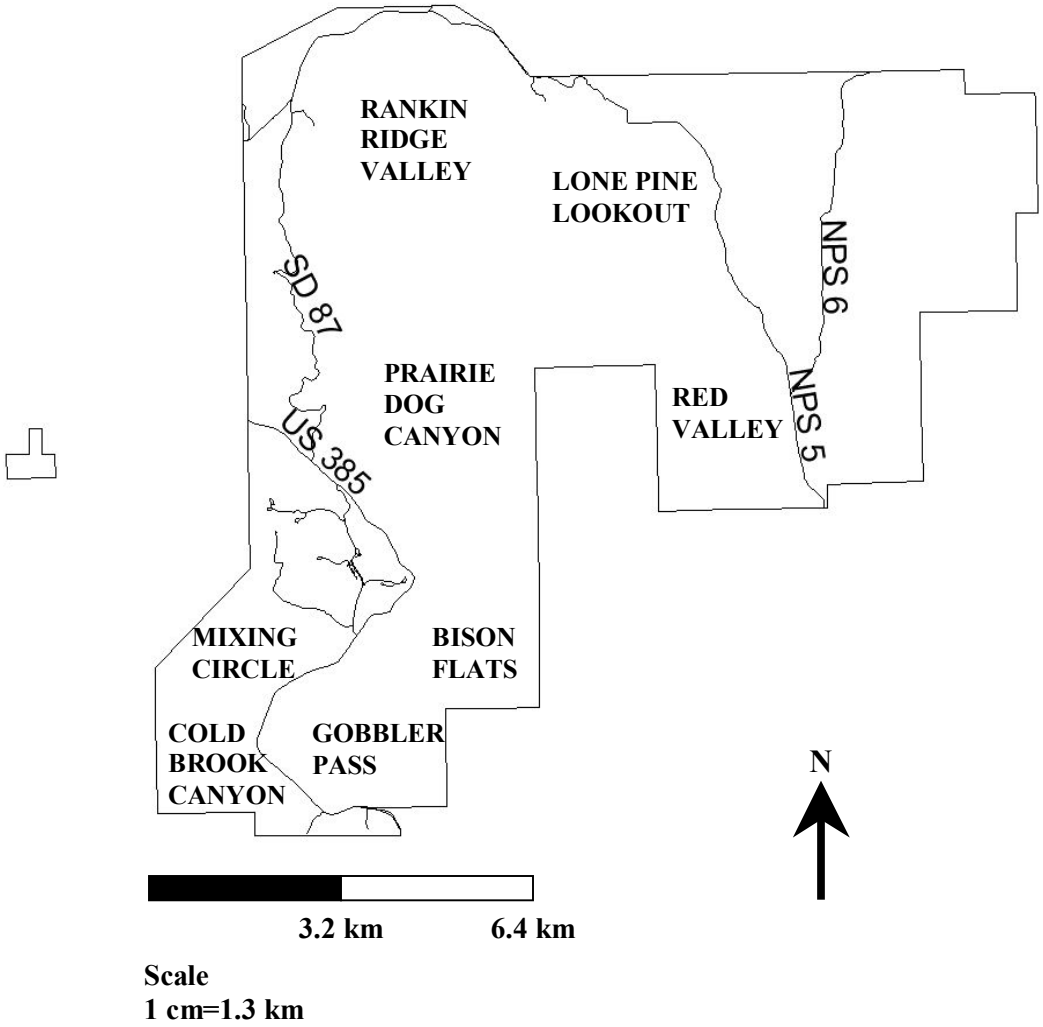


Figure 2. Grassland regions associated with pronghorn use in Wind Cave National Park, 2002-03.

CHAPTER 2

MOVEMENTS OF PRONGHORN IN WIND CAVE NATIONAL PARK

INTRODUCTION

Daily and seasonal movements, as well as, patterns of movement have been described for pronghorn in several western states (Martinka 1966, Hoskinson and Tester 1980, Boccadori and Garrott 2002). Previous studies of pronghorn have described short distance movements as well as long distance migrations. Snow depth, duration of snow cover, and moisture content of vegetation may initiate autumn and spring migrations of pronghorn and contribute to determination of winter ranges. Several studies have suggested that pronghorn are opportunistic winter migrants, and movements are prompted by changing environmental conditions (Pepper and Quinn 1965, Bruns 1977, Hoskinson and Tester 1980, Barrett 1982). Ryder and Irwin (1987) acknowledged that winter ranges were established based on forage abundance and pronghorn densities, with the most suitable habitats being used first. Spring migration may be more closely associated with snowmelt. Movement by pronghorn in southeastern Idaho during spring migration was prompted by the break up of snow cover (Hoskinson and Tester 1980). While pronghorn are capable of such movements, some populations may not exhibit migratory behavior (Boccadori and Garrott 2002). There is evidence to suggest that pronghorn are opportunistic migrants, and often exhibit such behavior when prompted to do so by changing environmental conditions (Pepper and Quinn 1965).

Survival and mortality of adult pronghorn are of importance when studying declining or isolated populations. Winter mortality of pronghorn has been studied in some western states and Canadian provinces (Trueblood 1956, Martinka 1967, Barrett 1982). Presence of quality habitat can influence seasonal survival of adult pronghorn.

Pronghorn frequently used habitat subjected to prescribed burns in southeastern Alberta during autumn, late winter, and early spring; thereby, increasing pre-winter condition and winter survival (Courtney 1989). Topography has been reported to be of importance to pronghorn survival in winter months, as well (Bruns 1977, Ryder and Irwin 1987). In this study, adult female pronghorn were observed to determine the frequency and duration of movements of pronghorn in WCNP.

METHODS

Adult female pronghorn in WCNP were captured using a helicopter capture service (Helicopter Capture Service, Marysville, UT) equipped with a modified 0.308 caliber net gun in January of 2002. Females were fitted with radio collars (151 MHz) equipped with mortality switches (Advanced Telemetry Systems, Isanti, MN), aged based on incisor wear (Dow and Wright 1962), and measured around the chest and along the right rear foot at the time of capture. Collared females were located 2 to 3 times per week using radio telemetry. Radio telemetry has been shown to be an effective method for observing migration behavior and cause-specific mortality within pronghorn populations (Bayless 1969, Beale and Smith 1973, Hoskinson and Tester 1980, Barrett 1981, Ryder and Irwin 1987). Individual adult males were not radiocollared, but locations were recorded when individuals were observed. Adult males were identified by horn characteristics and variation in neckband coloration (Byers 1997).

Radiocollared adult female pronghorn were located using a hand-held telemetry receiver and directional antenna (Telonics Telemetry Electronics Consultants, Mesa,

Arizona; ICOM, Bellevue, Washington). A Garmin III GPS (Global Positioning System) was used to record locations once collared animals had been visually observed. Locations of mortalities were recorded using this same method. Locations were entered into an Arcview 3.3 Geographic Information System (ERSI, Redlands, California) and analyzed to determine daily and seasonal movements of pronghorn within the park. Seasonal home range polygons were calculated using the adaptive kernel method with CALHOME software (Kie et al. 1996). A parametric t-test was used to test for seasonal differences in movement. All tests were conducted using a statistical significance level of $P<0.05$ unless noted otherwise (Zar 1984).

RESULTS

Eleven adult female pronghorn were captured and processed. Age of captured pronghorn ranged from 1.5 to 6.5 years (Appendix A). Three mortalities occurred as a result of the capture, yielding a capture mortality rate of 27.3%. Injuries occurring due to capture included a broken pelvis and capture myopathy. One death was confirmed 6 days following capture, while 2 mortalities were confirmed the day of capture (Appendix E).

A total of 407 independent locations of radiocollared adult female pronghorn (n=8) were obtained from 26 January 2002 to 31 May 2004. Radiocollared females were located in the Bison Flats, Rankin Ridge Valley, and Red Valley regions of WCNP (Figure 2). During the summer months of 2002 and 2003, 283 locations were obtained on radiocollared females (Figure 3). One hundred twenty-four locations were collected on females during the winters of 2002, 2003, and 2004 (Figure 4). Ninety-five percent

home range contours calculated for adult females were 54.5 km^2 (n=8, SE=8.7) in summer and 66.6 km^2 (n=8, SE=9.8) in winter (Table 1). Fifty percent core use contours calculated for adult females were 7.3 km^2 (n=8, SE=1.7) in summer and 7.2 km^2 (n=8, SE=1.2) in winter (Table 1). There were no significant differences in 95% (t=0.921, df=14, P=0.373) or 50% (t=0.051, df=14, P=0.960) ranges between winter and summer in 2002. Daily distance traveled by adult females between successive location points averaged 2.5 km (n=8, SE=0.15) in summer and 2.6 km (n=8, SE=0.20) in winter (Table 1). Mean daily distance traveled ranged from 1.8 km in September and October to 3.6 km in December (Figure 6). Movement by pronghorn females in January 2002 could have been influenced by capture. Therefore, distance values obtained during that month may not accurately reflect pronghorn behavior. Daily distances traveled in winter and summer were not significantly different (t=0.655, df=8, P=0.457). Movements between the northern and southern grassland areas were recorded during winter and summer months for 8 females during the study period. The longest distance moved by a radiocollared pronghorn in WCNP was 11.5 km over a two-day period in April 2002 (Appendix B). The longest distance moved in a 24-hour period was recorded for 4 females that traveled 9.6 km in November 2002. Two radiocollared females were observed in Custer State Park near the border with WCNP during the winter of 2003-04. These were the only observations of radiocollared pronghorn outside the boundaries of WCNP. Mean group size ranged from 17 individuals per group in December to 2 individuals per group in June 2002 (Figure 8).

Survival of adult female pronghorn in 2002 and 2003 was 87.5% (0.875±0.214, 95% CI) and 85.7% (0.857±0.259, 95% CI), respectively (Table 6). Predation accounted for 100% of natural mortality in radiocollared adults, including one adult female in December of 2002 and one adult female in June of 2003. The adult female killed in June 2003 was the birth mother to a 1 week-old radiocollared fawn. The radiocollared fawn died from starvation 7 days after capture occurred.

One hundred seventy-seven locations were obtained on adult males (n=3) between 26 January 2002 and 31 May 2004. An additional male was observed in WCNP in the summer of 2003 that was not identified in 2002. Each male exhibited unique horn characteristics and neckband coloration. These features made it possible to identify males from a distance using a spotting scope (Bushnell Performance Optics, Overland Park, KS). Two males were frequently observed in the Red Valley and Rankin Ridge Valley, which were located in the northern region of WCNP (Figure 5). One male was often observed in the Bison Flats area, which was located in the southern region of WCNP (Figure 5). The fourth male was not observed during 2002; thus, home range could not be determined for that individual.

DISCUSSION

High capture mortality of adult pronghorn was associated with handling techniques and lack of snow cover during capture. Captured pronghorn were hobbled and suspended from the helicopter during transport to the processing site. Handling

techniques could have been improved by fitting pronghorn with radiocollars at the capture site, which would have reduced handling time and minimized stress.

Natural mortality of adults was observed infrequently in WCNP. Attempts by coyotes to kill pronghorn adults often resulted in unsuccessful chases. Pronghorn were consistently able to escape from coyotes. However, during summer months pronghorn females became more aggressive towards coyotes when defending fawns. Pronghorn mothers successfully defended their fawns by charging toward coyotes. This defensive behavior also put pronghorn mothers at greater risk for predation during summer months and likely contributed to a death of a radiocollared adult female.

Winter mortality of radiocollared pronghorn in WCNP was 12.5% over a 2-year period, which was considerably less than previously reported. Prolonged periods of significant snow cover were observed infrequently during winter months. Mortality of pronghorn in southeastern Alberta reached 48.5% during severe winters characterized by extreme temperatures and accumulating snow depths (Barrett 1982). Winter loss of more than 500 pronghorn or up to 15% of the herd was reported from mid-January until spring migration in April in Montana (Trueblood 1956, Martinka 1967).

Pronghorn existed at low densities, and movements of pronghorn occurred throughout WCNP. Snow depth and moisture content of vegetation have been suggested as factors influencing migration behavior of pronghorn. Autumn migration by pronghorn in southeastern Idaho was stimulated by changes in the moisture content of vegetation, with pronghorn moving to foraging areas with the highest moisture content (Hoskinson and Tester 1980). In southeastern Alberta, Canada, pronghorn occupied alternative

winter ranges characterized by low snow accumulations, when typical winter ranges accumulated record snowfall amounts (Barrett 1982, Bruns 1977). However, during average winters, Barrett (1982) reported that pronghorn used traditional winter ranges in Alberta.

Migratory behavior was not observed in radiocollared pronghorn in WCNP. Constraints placed on pronghorn in WCNP may have been different from obstacles encountered by free-ranging populations. Fencing structures likely prohibited pronghorn from establishing seasonal ranges or migrating in response to extreme weather conditions. The opportunity for pronghorn to move across cattle guards did not exist during winter months in 2002 and 2003. However, deep trenches existed along the boundary fence that that may have been used by pronghorn to move north into Custer State Park or south to private lands. It is likely that these trenches provided opportunities for movement by pronghorn between WCNP and surrounding lands.

The distribution of adult pronghorn during this study was of importance as well. Bromley (1977) identified territories for 10 adult males within the Bison Flats region of WCNP during 1970-72. However, daily observations of pronghorn during this study suggested that only 1 adult male established a territory within the Bison Flats region. Also, aerial censuses estimated that 65 pronghorn inhabited the Bison Flats region during 1970 (Bromley 1977). Conversely, ground counts of pronghorn during this study estimated that less than 10 pronghorn occupied the Bison Flats region.

The greatest distance moved by pronghorn during this study (12 km) was less than documented movements of pronghorn in western states. Martinka (1966) reported

migrations by pronghorn of 160 km in Montana. While pronghorn are capable of such movements, some populations may not exhibit migratory behavior. A non-migratory herd of pronghorn in Yellowstone National Park, Wyoming, remained on the winter range throughout the year (Boccadori and Garrott 2002). Fencing structures likely limited opportunities for pronghorn to move great distances in response to changing environmental conditions during this study. Sizes of winter (mean=66.6 km^2) and summer (mean=54.5 km^2) home ranges for pronghorn in WCNP were within the range of what has been reported for pronghorn across western North America (20-1144 km^2) (Yoakum and O'Gara 2000). However, winter home range size for pronghorn in WCNP was greater than what has been reported for some neighboring states. Average winter home range size for adult female pronghorn was 11.5 km^2 in central Montana (Bayless 1969). Given that fencing structures inhibited movements of ungulates in WCNP, the quality of the habitat available to pronghorn and other ungulates was of importance.

Presence of quality habitat can be critical during winter months. Pronghorn herds in southeastern Alberta and northern Montana selected microhabitats within feeding areas characterized by lower wind velocities, reduced snowfall, and softer snow during winter months (Bruns 1977). A combination of protected draws and exposed ridges provided cover and safety from harsh weather and deep snow for pronghorn in south-central Wyoming (Ryder and Irwin 1987). Therefore, habitat containing these protected areas may be critical for over winter survival of pronghorn in WCNP as well.

Table 1. Seasonal movement data for adult pronghorn females in Wind Cave National Park, 2002.

All radiocollared pronghorn	Summer movements km (*n*, SE)	Winter movements km (*n*, SE)	Pooled movements km (*n*, SE)	Summer 95% home range km^2 (*n*, SE)	Winter 95% home range km^2 (*n*, SE)	Summer 50% home range km^2 (*n*, SE)	Winter 50% home range km^2 (*n*, SE)
	2.5	2.6	2.5	54.5	66.6	7.3	7.2
	(*8*, 0.15)	(*8*, 0.20)	(*8*, 0.12)	(*8*, 8.7)	(*8*, 9.8)	(*8*,1.7)	(*8*, 1.2)

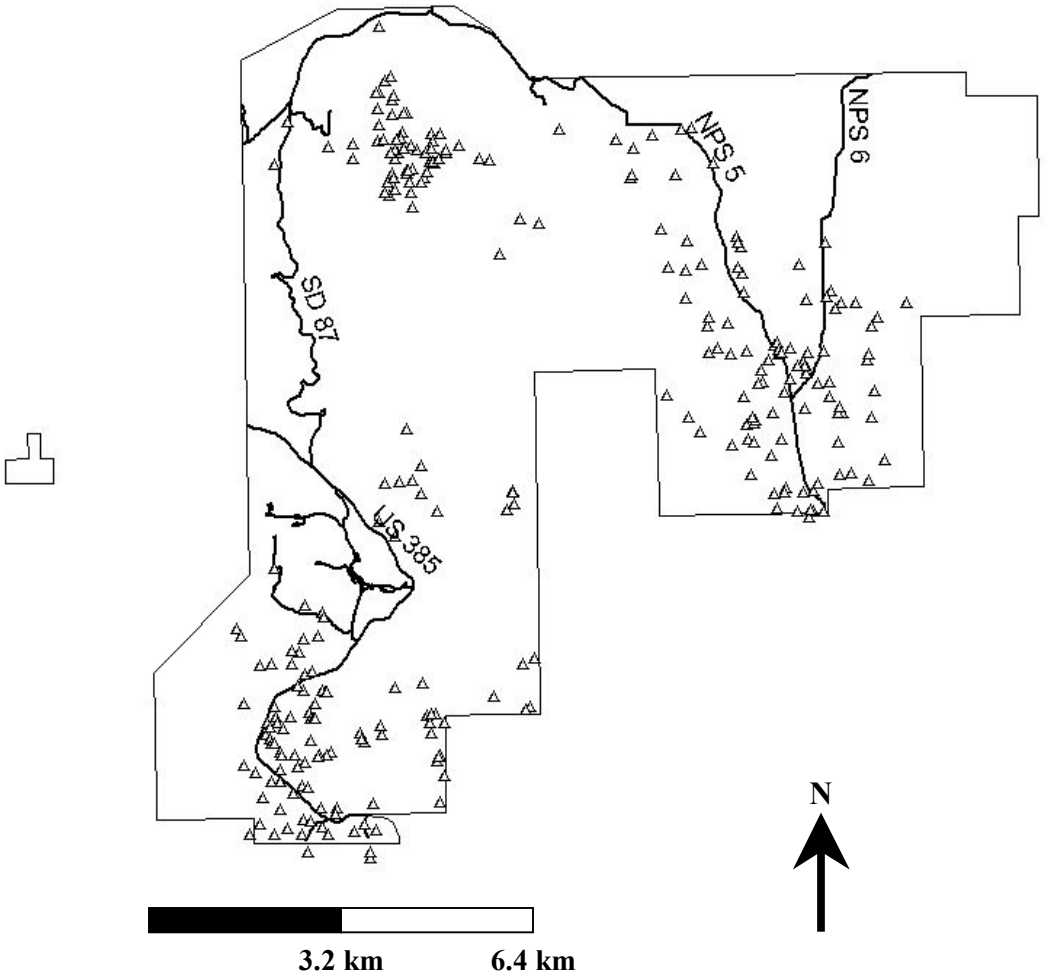


Figure 3. Summer locations (*n*=283) of female pronghorn in Wind Cave National Park, 2002-03.

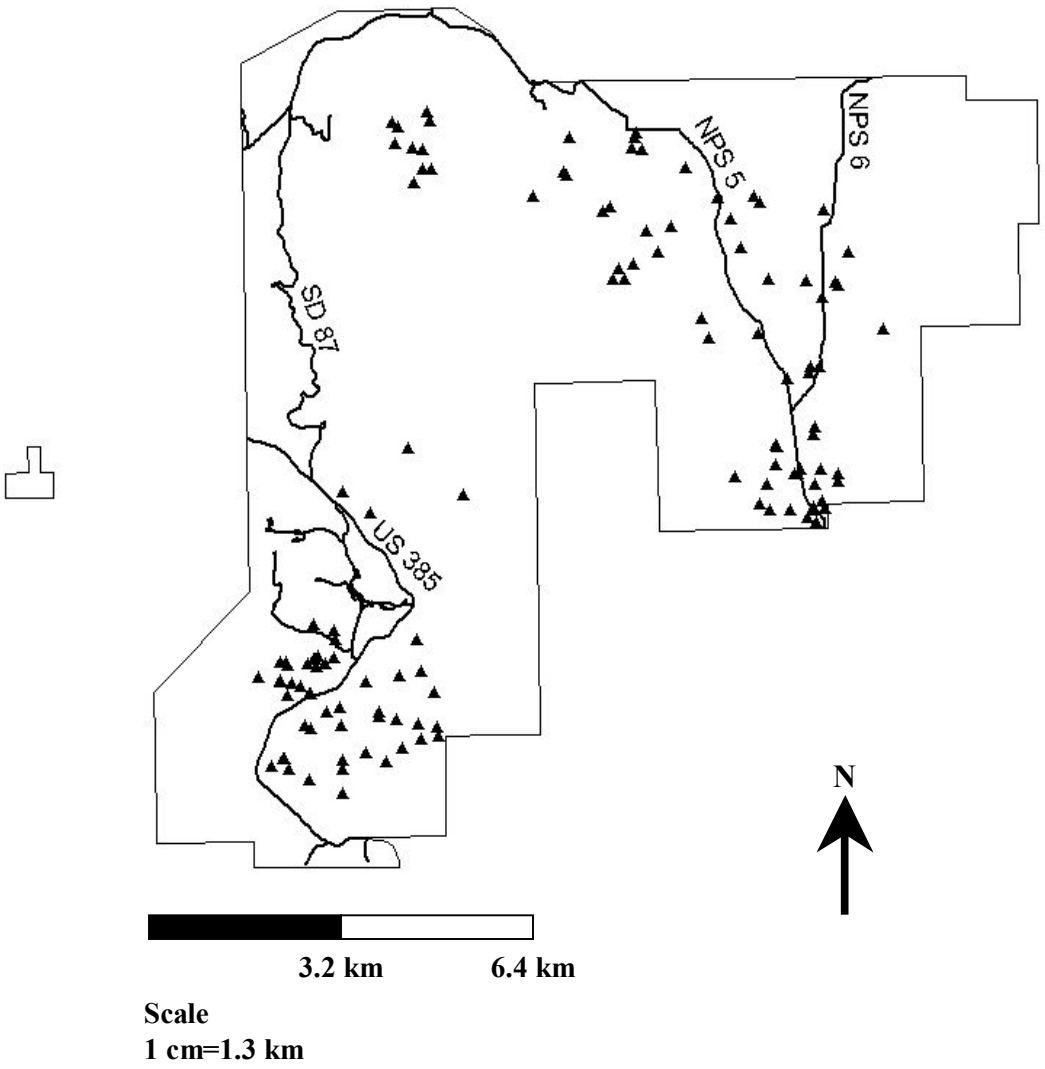
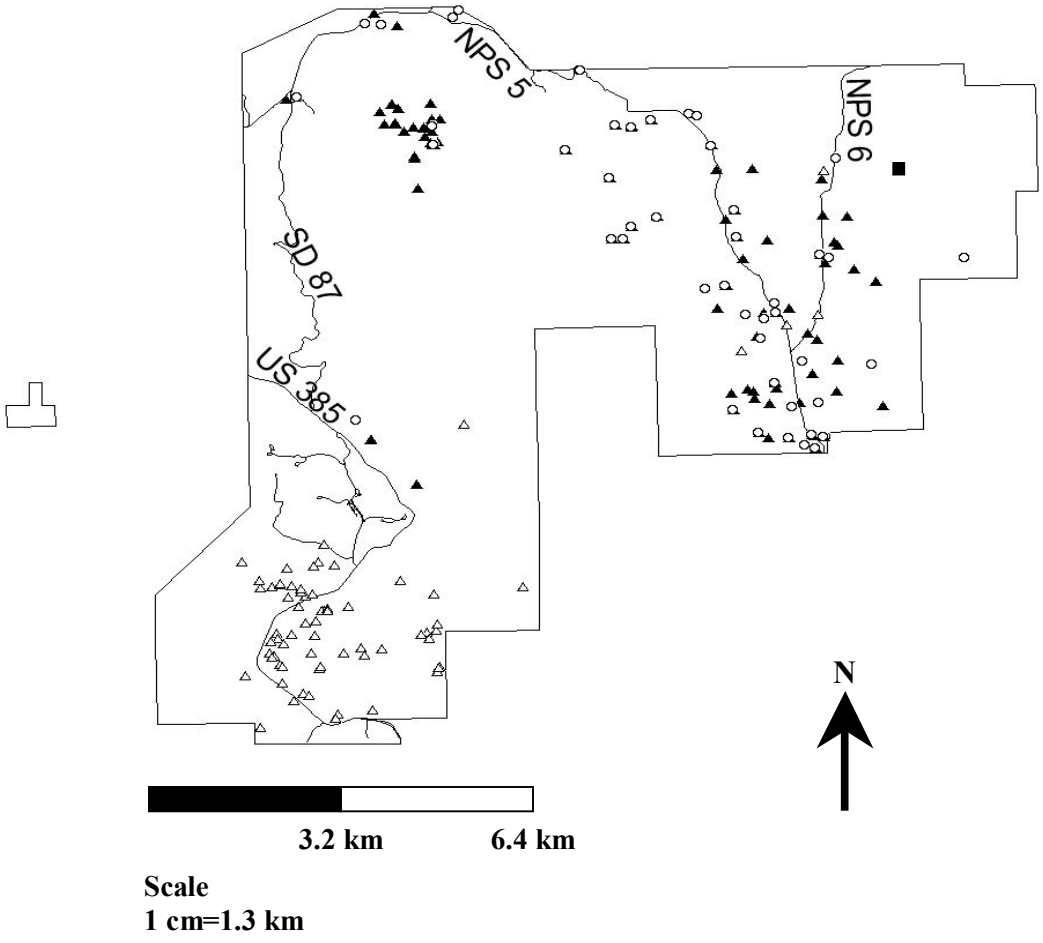


Figure 4. Winter locations (*n*=124) of female pronghorn in Wind Cave National Park, 2002-03.



▲ 01 (Rankin Ridge, Red Valley)

o 03 (Rankin Ridge, Red Valley)

△ 02, (Bison Flats)

■ 04 (Red Valley)

Figure 5. Locations (*n*=177) of male pronghorn in Wind Cave National Park, 2002.

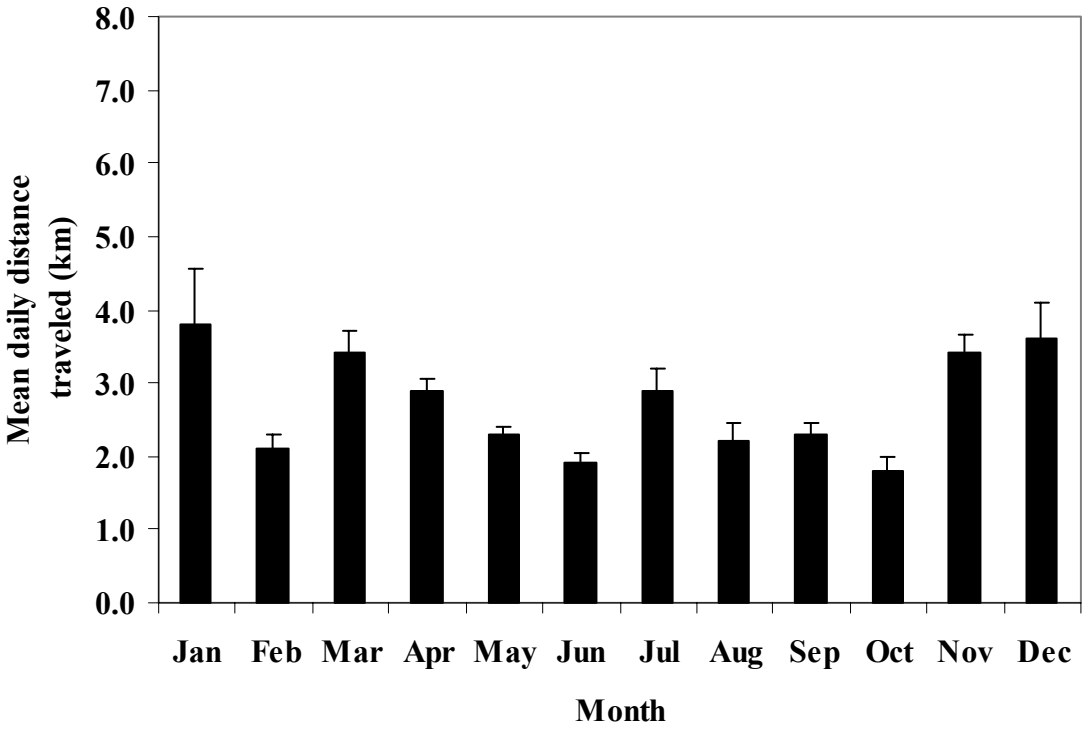


Figure 6. Daily movement data for female pronghorn in Wind Cave National Park, 2002.

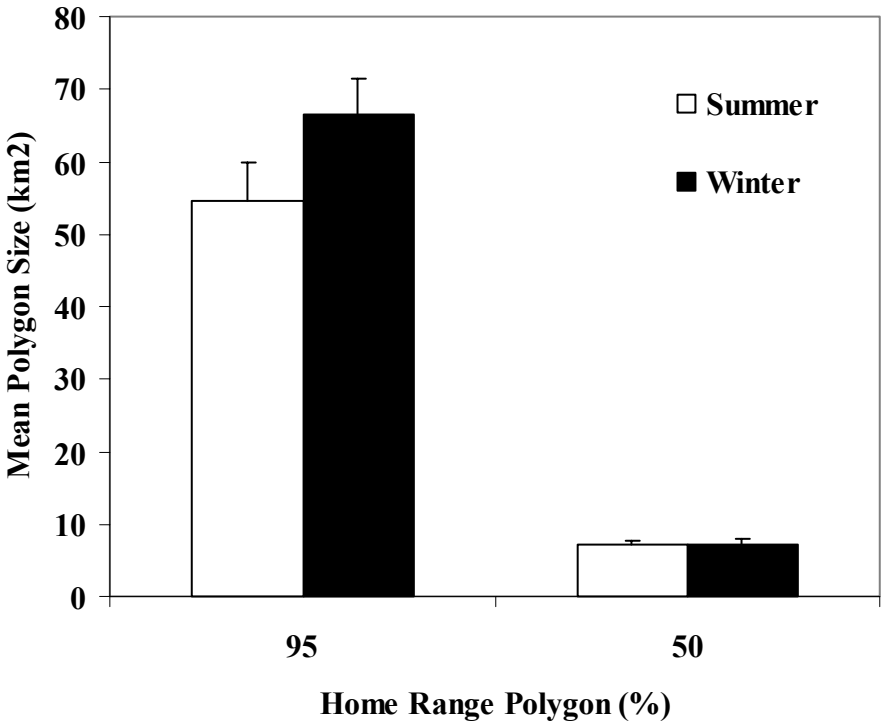


Figure 7. Mean home range size for female pronghorn in Wind Cave National Park, 2002.

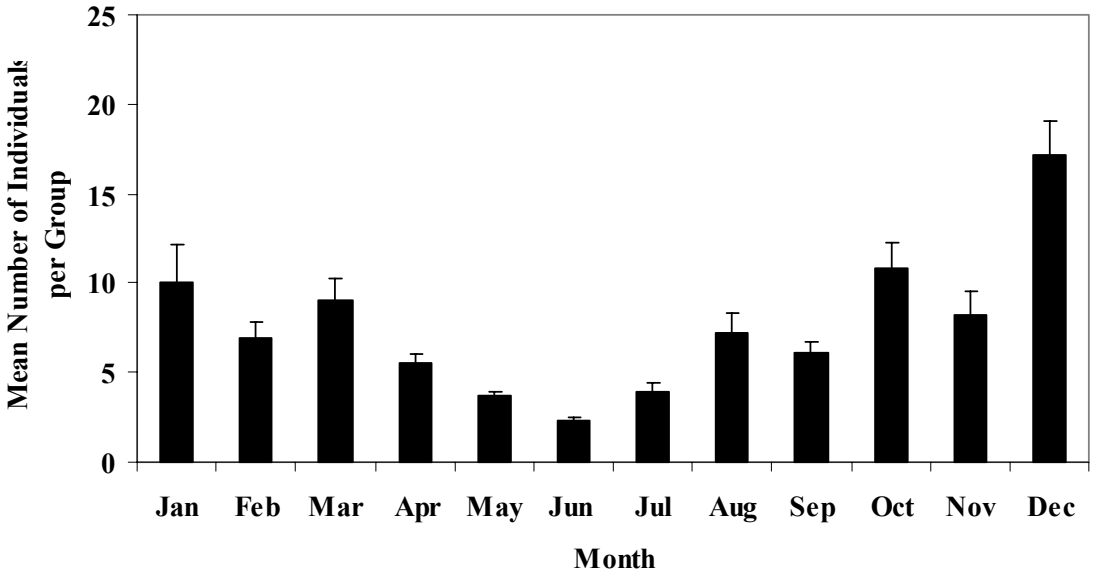


Figure 8. Size of groups for pronghorn in Wind Cave National Park, 2002.

CHAPTER 3

SURVIVAL OF PRONGHORN NEONATES IN WIND CAVE NATIONAL PARK

INTRODUCTION

Mortality of pronghorn neonates can contribute to population declines by removing individuals that would eventually contribute to reproduction. Potential factors associated with fawn mortality include predation, poor nutrition, adverse weather, and disease (Beale and Smith 1973). However, predation has been identified as the main cause of mortality in pronghorn fawns (Barrett 1984). Presence of coyotes and other predators can pose a threat to small pronghorn populations (Byers 1997, Gregg et al. 2001). White-tailed deer and pronghorn accounted for the greatest portion of coyote diets by fresh weight in the Black Hills of western South Dakota (Gerads et al. 2001). Other predators, including bobcats, may be responsible for significant losses of pronghorn fawns as well (Beale and Smith 1973).

Sex ratios of pronghorn neonates are of importance within small or declining populations. An adult female that successfully raises twins has replaced itself and contributed to an increase in the population in a single year. Also, pronghorn females are capable of being reproductively active for several years. Therefore, sex ratios favoring females may benefit declining populations. Sex ratios of offspring in polygynous mammals are influenced by the reproductive strategies of the species and physical condition of breeding adults. A sex ratio favoring newborn males may occur to compensate for increased rates of mortality in male offspring (Charnov 1982, Clutton-Brock and Iason 1986) or to improve future mating success for males in populations where reproductive success is significantly greater for females (Trivers and Willard

1973). Sex ratios favoring females have been documented for captive herds of ungulates in Canada, with breeding females in good physical condition (Hoefs and Nowlan 1994). Less is known about distorted sex ratios in pronghorn populations exposed to increased rates of mortality. However, pronghorn neonates on the National Bison Range maintained balanced sex ratios during periods of significant fawn mortality (Byers 1997).

Selection of bed sites by pronghorn fawns can be important to protect newborns during their first few weeks of life. Studies of fawn bed sites in Texas documented height and density of vegetation as important variables (Tucker and Garner 1983, Alldredge et al. 1991, Canon and Bryant 1997). In this study, pronghorn neonates were observed following parturition to determine the causes (e.g., predation, exposure) and extent of mortality during the first 45 days of life. Also, habitat used by pronghorn neonates during the first 3 weeks of life was examined to document vegetative characteristics of daytime bed sites.

METHODS

Neonatal pronghorn were captured and fitted with breakaway collars (166 MHz) (Advanced Telemetry Systems, Isanti, MN) in June of 2002 and May, June, and July of 2003. Twins were captured, when possible, to investigate maternal investment and defense of siblings by birth mothers. The second member of each twin pair was not included in estimates of survival. Neonates were captured using the observation method described by Byers (1997). Solitary, lactating females were observed for extended periods during daylight hours while neonates were nursed and relocated. Once the

reunion period ended between a female and its young, neonates were approached and physically restrained. Pronghorn fawns were not approached if predators (e.g., coyotes, bobcats, mountain lions, and golden eagles) were visually observed in the area. Sex and age of captured fawns were determined using new hoof growth and other physical characteristics (Haugen and Speake 1958, Tucker 1979). Body weight of captured fawns was determined using a cloth sling and a 5-kg hanging scale (Chatillon Company, New York, New York). To minimize stress and capture related mortality, fawns were handled with sterile gloves and rubbed with native vegetation after processing. Byers (1997) reported that the mortality risk to young pronghorns did not increase due to handling when proper precautions were taken. Fawns were located daily during the first 45 days of life. Radiocollared fawns were relocated using a hand-held telemetry receiver (Telonics Telemetry Electronics Consultants, Mesa, Arizona; ICOM, Bellevue, Washington). The Kaplan-Meier survival program (Pollock et al. 1989) was used to estimate survival rates of radiocollared neonates and construct confidence intervals used for comparisons of survival between years.

Pronghorn fawn daytime bed sites were located by direct observation within WCNP. Bed sites were defined as the area immediately surrounding the fawn at the time of location. Habitat information was measured 1-10 days after the fawns had moved to a new location. All efforts were made to ensure that fawns were not disturbed. Random bed sites were generated using the Alaskapak extension to Arcview 3.3 software (ERSI, Redlands, California). A modification of the 20 x 50 cm plot method developed by Daubenmire (1959) was used to sample daytime bed sites. The bed site was the center of

4 transects placed up slope, down slope, and perpendicular to the slope. Ten quadrats were sampled at 20-cm intervals along each transect line. In each quadrat, height of the tallest plant species (e.g., forb, shrub, or grass) or rock was measured to the nearest 1 cm. Abundance of grasses, forbs, and shrubs, determined through visual observation, were ranked in order of dominance from 1 (most dominant) to 4 (not present). This information was used to document vegetative composition around the bed site. Bed site measurements were conducted between 15 May and 30 June of 2002 and 2003, when cover selection was most important to fawns (Pyrah 1987). Habitat information also was collected from random locations. Bed sites of fawns greater than three weeks of age were not measured. A t-test was conducted to detect differences in height of vegetation between bed and random sites and years. Chi-square analysis was used to test for differences in dominance of grasses, forbs, and shrubs between bed sites and random sites. All tests were conducted using a statistical significance level of $P<0.05$ unless otherwise noted (Zar 1984).

RESULTS

Thirteen neonates were captured from 9 individual adult females and radiocollared between 5 June and 11 June of 2002. An additional 13 pronghorn neonates were captured from 10 individual adult females and radiocollared between 31 May and 5 July of 2003. Overall, 9 males and 17 females were captured. The sex ratio of offspring was 1:1.9 (male:female) over the 2-year period. Mean weight of males was 3.4 kg (n=6, SE=0.229), and mean weight of females was 3.5 kg (n=16, SE=0.168) overall (Table 2).

A total of 148 locations of radio-collard fawns (*n*=19) was obtained between 5 June 2002 and 31 August 2003 (Figure 9).

Survival rates of pronghorn neonates were calculated in 4 fawn rearing areas within WCNP, including the Red Valley (3/9=33.3%), Rankin Ridge Valley (2/3=66.6%), Prairie Dog Canyon (0/1=0.0%), and Bison Flats (1/5=20.0%) regions (Figure 10). Pooled survival at the end of summer was 26.1% (*n*=18, Table 3). In 2002, survival of males at the end of summer was 25% (*n*=4, $\pm$0.424, 95%CI), while survival of females at the end of summer was 20% (*n*=5, $\pm$0.351, 95% CI) (Table 4). In 2003, survival of males at the end of summer was 25% (*n*=3, $\pm$0.300, 95% CI), and survival of females at the end of summer was 33% (*n*=6, $\pm$0.377, 95% CI) (Table 5). Survival of all pronghorn neonates during the 45 days following birth was 22% (*n*=9, $\pm$0.222, 95% CI) in 2002 and 42% (*n*=9, $\pm$0.255, 95% CI) in 2003 (Table 6).

Predation was the greatest single cause of mortality in fawns during each year (Table 7). One fawn was killed by bobcats, based on remains found at the kill site and documented kills of pronghorn neonates by bobcats (Beale and Smith 1973). Five deaths occurred from unknown predators and 6 deaths were attributed to coyote predation. Mortality attributed to unknown predators likely included coyotes, but insufficient evidence existed for species-specific determination. One fawn was abandoned after capture, and 1 fawn died of starvation after the mother was killed by coyotes. Seven sets of twins (4 in 2002, 3 in 2003) were radiocollared to investigate maternal investment and defense of twin pairs by pronghorn females. Four sets of twins were killed by predators

during the summer and 2 sets of twins survived to adulthood. A member of 1 twin pair was abandoned shortly after capture, while the other fawn survived to adulthood.

Reproductive effort was estimated at 1.37 fawns per adult female during the study. Several other adult females were observed with more than 1 fawn during summer months. However, it could not be determined if multiple births had occurred with those fawns that were not captured and radiocollared.

Ten bed sites and 23 random sites were sampled from 13 June to 22 June 2002. Forty bed sites and 27 random sites were sampled from 16 June to 26 June 2003. Bed sites and random sites were located in the Red Valley, Rankin Ridge Valley, and Bison Flats regions of WCNP (Figure 11). Height of vegetation was greatest in the Rankin Ridge Valley (mean=45.5 cm, n=2, SE=4.8) in 2002 and in the Red Valley (mean=41.9 cm, n=36, SE=1.3) in 2003 (Table 8). Statistical tests were not used to determine if differences existed between heights of vegetation between grassland regions because sample size within some regions was insufficient. Overall, mean height of plant species around fawn bed sites was 39.1 cm (SE=0.7) in 2002 and 41.1 cm (SE=0.3) in 2003 (Figure 12). Random sites averaged 38.9 cm (SE=0.5) and 35.8 cm (SE=0.5) during 2002 and 2003, respectively (Figure 12). Differences were not observed in height of vegetation between bed sites and random sites in 2002 (t=0.052, df=31, P=0.956), but significant differences were detected in 2003 (t=1.921, df=65, P=0.059). Grasses occurred with the greatest frequency and shrubs occurred with the least frequency in all bed sites and random sites during 2002 (Table 9) and 2003 (Table 10). No significant differences (t=1.563, df=31, P=0.128) in plant dominance between bed sites and random

sites were detected for any category during 2002. Differences in the most dominant (1) and not present (4) dominance categories of grass and forb species were detected between bed sites and random sites in 2003. Grasses dominated bed sites in greater proportion (t=2.617, df=65, P=0.011) than random sites. Forbs were absent from bed sites in greater proportion (t=2.731, df=65, P=0.008) than random sites. Forbs also dominated random sites in greater proportion (t=3.221, df=65, P=0.002) than bed sites. No differences were detected for dominance of shrub species between bed sites and random sites during either 2002 (t=1.563, df=31, P=0.128) or 2003 (t=1.427, df=65, P=0.158). Shrub species did not occur at a frequency greater than 11.3% in bed sites or random sites during either year of the study.

DISCUSSION

The ratio of fawns observed in WCNP was skewed toward females during both years of the study. It could not be determined if this phenomenon was a response by breeding females to lower densities or just due to random chance. If information on neonate sex ratios from previous years was available, comparisons could have been made with other long-term studies of pronghorn sex ratios in western North America. Byers (1997) reported that pronghorn neonates on the National Bison Range maintained sex ratios near 50% despite mortality rates ranging from 1-44% during a 15-year period.

Survival rates of neonates in this study were similar to what has been reported in other studies, where coyotes have been identified as a significant source of mortality. Byers (1997) observed annual fawn mortality rates on the National Bison Range between

56-99%, with coyotes being the primary predatory species. Gregg et al. (2001) reported that fawn mortality reached 84% over a 2 year period in Oregon, with coyote predation accounting for as much as 86% of the fawn deaths. Bobcats existed in WCNP and accounted for the death of at least 1 pronghorn neonate during this study. However, bobcats have been documented as the most significant source of mortality in pronghorn fawns in some areas. Bobcats accounted for 61% of fawn mortalities in Utah, with overall fawn mortality reaching 42% over a 5-year period (Beale and Smith 1973). However, densities of bobcats in WCNP at the time of this study were largely unknown.

Changes in predator densities may have influenced neonate survival between 2002 and 2003. Sarcoptic mange (*Sarcoptes scabiei*) contributed to the deaths of about 40% of radiocollared coyotes during 2003 (J. Chronert South Dakota State University, unpublished data), which may have resulted in lower coyote densities in WCNP. Coyote densities in WCNP during this study were estimated to be over 1 coyote per km^2 (J. Chronert South Dakota State University, unpublished data). Coyote densities in WCNP were higher than what has been reported in other populations in western South Dakota and across western North America (Springer 1982, Gerads et al. 2001). Gerads et al. (2001) reported that relative densities of coyotes in western South Dakota were higher in the Black Hills than in the prairies of northwest and west-central South Dakota. Densities of coyotes in south central Washington were estimated to be 1 coyote per 5.4 km^2 (Springer 1982).

Pooled fawn survival was high within the Rankin Ridge Valley of WCNP. This area contained steep hillsides and fragmented patches of grasslands surrounded by stands

of ponderosa pines. Several fawns were observed in this region in 2002, but only 1 fawn was observed in this area in 2003. Use of the Rankin Ridge Valley may have been a response by breeding females to drought conditions that were affecting other grassland areas during 2002. The fragmentation of grasslands by forested areas in the Rankin Ridge Valley likely reduced visibility of pronghorn fawns for sit-and-wait predators during the critical period. A greater number of fawns were observed during summer months in the Red Valley than in any other region in WCNP.

Pronghorn females having more than one radiocollared fawn either successfully raised both siblings to adulthood or lost both siblings to predators. The level of experience and the ability of pronghorn mothers to evade predators during the critical survival period likely influenced fawn survival in WCNP during this study. This was further supported by fact that a fawn born in July survived through the critical period despite being born well after the traditional fawning period. Similar findings were observed within pronghorn neonates in Colorado (Fairbanks 1993).

Height of cover and species composition were important components of bed sites selected by pronghorn neonates. Bedding sites in southeastern Alberta frequently contained little to no sagebrush (*Artemisia species*), but landscapes maintained diversity through the presence of small depressions, exposed areas of soil, and stands of grasses or forbs (Barrett 1981). Similar conditions existed within bedding sites in WCNP. Bromley (1977) reported that fawns selected bedding sites on bare patches of ground, which served as small, hollow areas and satisfied both vertical and horizontal requirements for protective cover. Fawns are more selective of cover within the first three weeks of life

(Fichter 1974). Furthermore, Byers (1997) suggested that fawns older than three weeks no longer use the hiding strategy that secludes them from predators.

Grasses were the most dominant plant species that occurred in bed sites. This would seem logical, as grasses dominated most areas within the park. Forbs were frequently present within bed sites but were less dominant than grasses. Mean height of tallest plant species at bed sites was similar between years, despite differences in rainfall during the growing season. Visibility for the bedded fawn and the birth mother may also have been an important characteristic of the bed site. Bed sites likely allowed for visual contact between bedded fawns and pronghorn mothers during reunion periods. Regional differences in the height of vegetation provided further support for the importance of cover for pronghorn neonates during the critical period. The greatest number of fawns was observed in the Rankin Ridge Valley in 2002 and in the Red Valley in 2003. Bed sites within these grassland regions exhibited the tallest vegetative cover for pronghorn neonates during those respective years (Table 8). Bed site selection was likely influenced both by the searching skills of predators and the visual abilities of pronghorn mothers and neonates.

Table 2. Capture data for pronghorn neonates in Wind Cave National Park, 2002-03.

	2002[a]			2003[b]			Overall		
Sex	Males	Females	All	Males	Females	All	Males	Females	All
Number of fawns captured	5	8	13	4	9	13	9	17	26
Mean (*n*, SE) handling time (minutes)	6.5 (*5*,0.678)	6.0 (*8*,0.227)	6.0 (*13*,0.296)	4.5 (*3*,0.363)	6.0 (*8*,0.618)	6.0 (*11*,0.533)	6.0 (*8*,0.592)	6.0 (*16*,0.324)	6.0 (*24*,0.287)
Mean (*n*, SE) weight (kg)	3.225 (*4*,0.333)	3.221 (*7*,0.139)	3.223 (*11*,0.139)	3.625 (*2*,0.125)	3.650 (*9*,0.269)	3.645 (*11*,0.218)	3.358 (*6*,0.229)	3.463 (*16*,0.168)	3.434 (*22*,0.134)

[a]Includes four sets of twins

[b]Includes three sets of twins

Table 3. Summary of survival analysis for pronghorn neonates over summer months in Wind Cave National Park, 2002-03.

	2002			2003			Pooled 2002-03		
Month	June	July	August	June	July	August	June	July	August
Number at risk	9	3	2	8	6	4	17	9	6
Number of deaths	6	1	0	3	2	1	9	3	1
Number censored	0	0	0	1	0	0	1	0	0
Survival rate	0.3333	0.2222	0.2222	0.6250	0.4167	0.3125	0.4706	0.3137	0.2614
Confidence interval (95%)	±0.1778	±0.2218	±0.2616	±0.2652	±0.2547	±0.1270	±0.1628	±0.1698	±0.1798
Variance	0.0082	0.0128	0.0192	0.0183	0.0169	0.0168	0.0069	0.0075	0.0084

Table 4. Monthly survival rates by sex of radiocollared pronghorn neonates in Wind Cave National Park, 2002.

	Males			Females		
Month	June	July	August	June	July	August
Number at risk	4	1	1	5	1	1
Number of deaths	3	0	0	4	0	0
Number censored	0	0	0	0	0	0
Survival rate	0.2500	0.2500	0.2500	0.2000	0.2000	0.2000
Confidence interval (95%)	±0.2122	±0.4244	±0.4244	±0.1568	±0.3506	±0.3506
Variance	0.0117	0.0469	0.0469	0.0064	0.0320	0.0320

Table 5. Monthly survival rates by sex of radiocollared pronghorn neonates in Wind Cave National Park, 2003.

	Males			Females		
Month	June	July	August	June	July	August
Number at risk	2	2	2	6	4	2
Number of deaths	1	0	1	2	2	0
Number censored	1	0	0	0	0	0
Survival rate	0.5000	0.5000	0.2500	0.6667	0.3333	0.3333
Confidence interval (95%)	±0.4900	±0.4900	±0.3001	±0.3080	±0.2668	±0.3772
Variance	0.0625	0.0625	0.0234	0.0247	0.0185	0.0370

Table 6. Summary of survival analysis for adult female and neonate pronghorn in Wind Cave National Park, 2002-03.

	2002		2003		Overall	
	Adults	Fawns	Adults	Fawns	Adults	Fawns
Number at risk	8	9	7	9	8	18
Number of deaths	1	7	1	5	2	12
Number censored	3	0	0	1	3	1
Survival rate	0.8750	0.2222	0.8571	0.4167	0.7500	0.3137
Confidence interval (95%)	±0.2144	±0.2218	±0.2593	±0.2547	±0.3001	±0.1698
Variance	0.0120	0.0128	0.0175	0.0169	0.0234	0.0075

Table 7. Summary of cause-specific mortalities that occurred on pronghorn neonates in Wind Cave National Park during the summer months, 2002-03.

Cause of Mortality	June	July	August	Total
Starvation	1	0	0	1
Predation	7	4	1[a]	12
Capture related	1	0	0	1
Total	9	4	1	14

[a]Neonate greater than 45 days of age when death occurred.

Table 8. Mean height of vegetation at bed sites (*n*=50) within the Bison Flats, Rankin Ridge Valley, and Red Valley regions of Wind Cave National Park, 2002-03.

	Bison Flats	Rankin Ridge Valley	Red Valley
Bed sites-2002			
Height (cm)	38.4	45.5	35.9
(*n*, SE)	(*5*, 5.29)	(*2*, 4.8)	(*3*, 3.1)
Bed sites-2003			
Height (cm)	34.9		41.9
(*n*, SE)	(*4*, 2.5)		(*36*, 1.3)

Blank cell represents "no data".

Table 9. Dominance rankings and frequency of vegetation around daytime bed sites of pronghorn neonates in Wind Cave National Park, 2002.

	Dominance ranking[b]				%
Plant type	1[a]	2	3[a]	4[a]	Frequency
Bed sites (*n*=10)					
Grass	96.8	2.8	0.3	0.3	99.8
Shrub	1.8	6.5	3.0	88.8	11.3
Forb	2.3	47.3	4.5	46.0	54.0
Random sites (*n*=23)					
Grass	92.3	6.0	0.0	1.5	98.5
Shrub	1.8	2.5	0.8	95.0	5.0
Forb	5.8	56.5	1.3	36.5	63.5

[a]Ranking=most dominant (1), least dominant (3), and not found (4).

[b]Values represent the percentage of sites receiving each ranking.

Table 10. Dominance rankings and frequency of vegetation around daytime bed sites of pronghorn neonates in Wind Cave National Park, 2003.

	Dominance ranking[b]				%
Plant type	1[a]	2	3[a]	4[a]	Frequency
Bed sites (*n*=40)					
Grass	94.0	4.3	0.8	0.5	98.9
Shrub	0.0	0.5	0.3	99.0	0.8
Forb	3.5	58.0	1.3	37.5	62.8
Random sites (*n*=27)					
Grass	82.3	17.3	0.0	0.0	99.6
Shrub	0.5	2.8	0.0	96.3	3.3
Forb	16.8	61.5	0.5	20.8	78.8

[a]Ranking=most dominant (1), least dominant (3), and not found (4).

[b]Values represent the percentage of sites receiving each ranking.

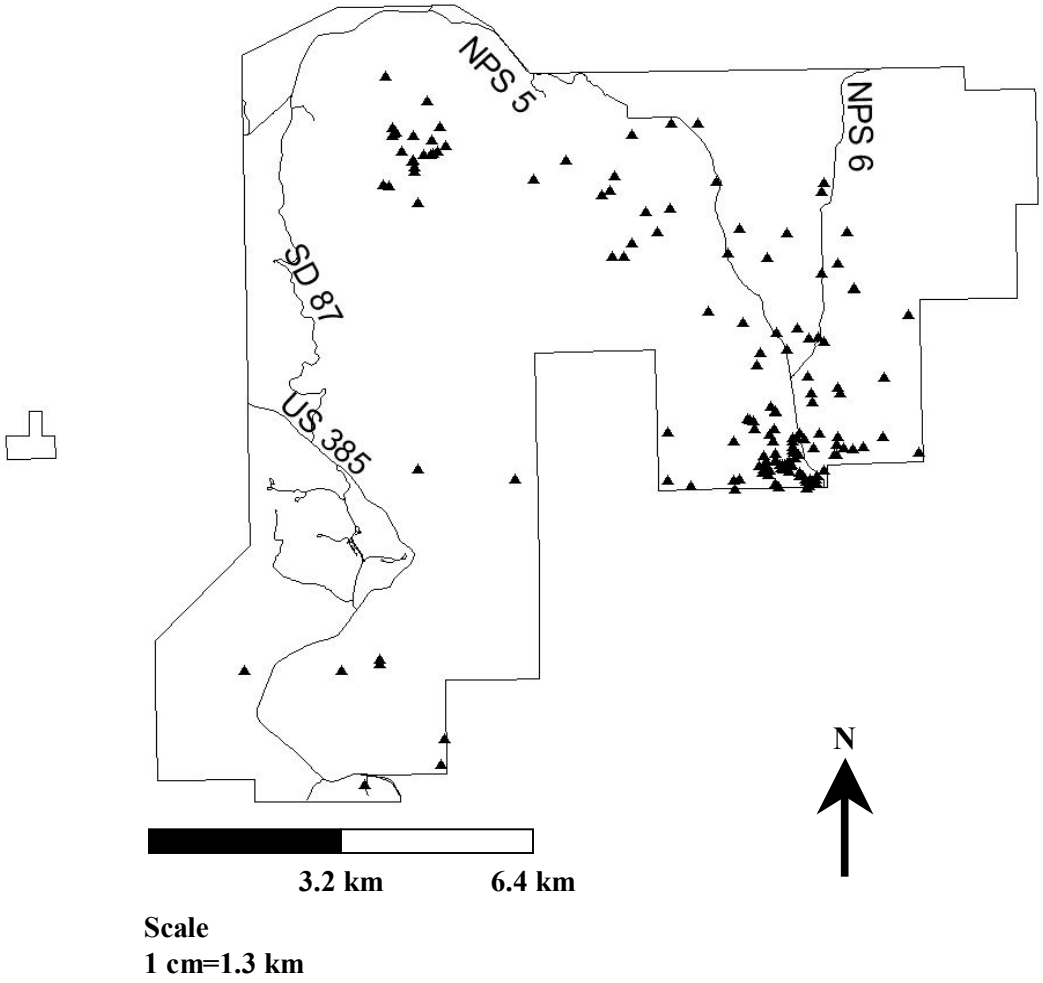


Figure 9. Locations (*n*=148) of pronghorn neonates in Wind Cave National Park, 2002-03.

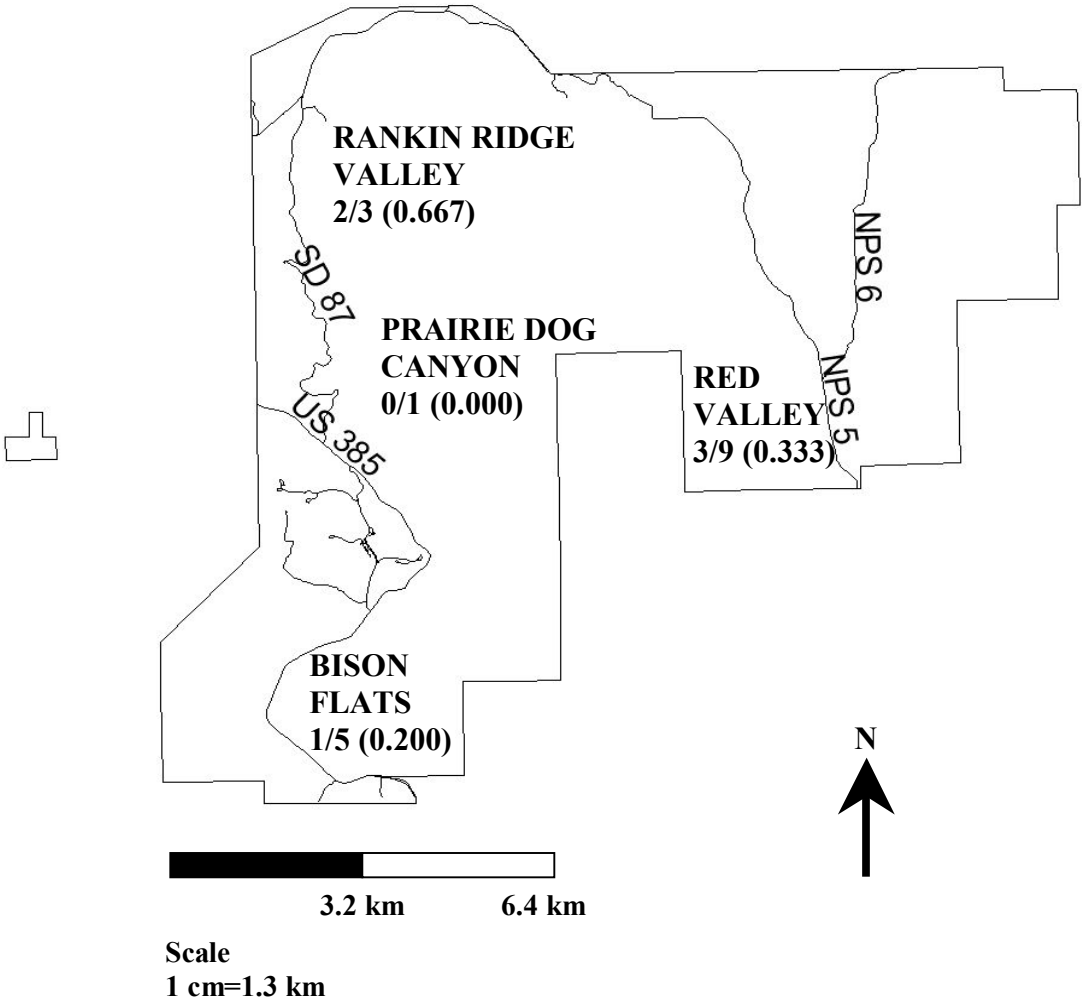
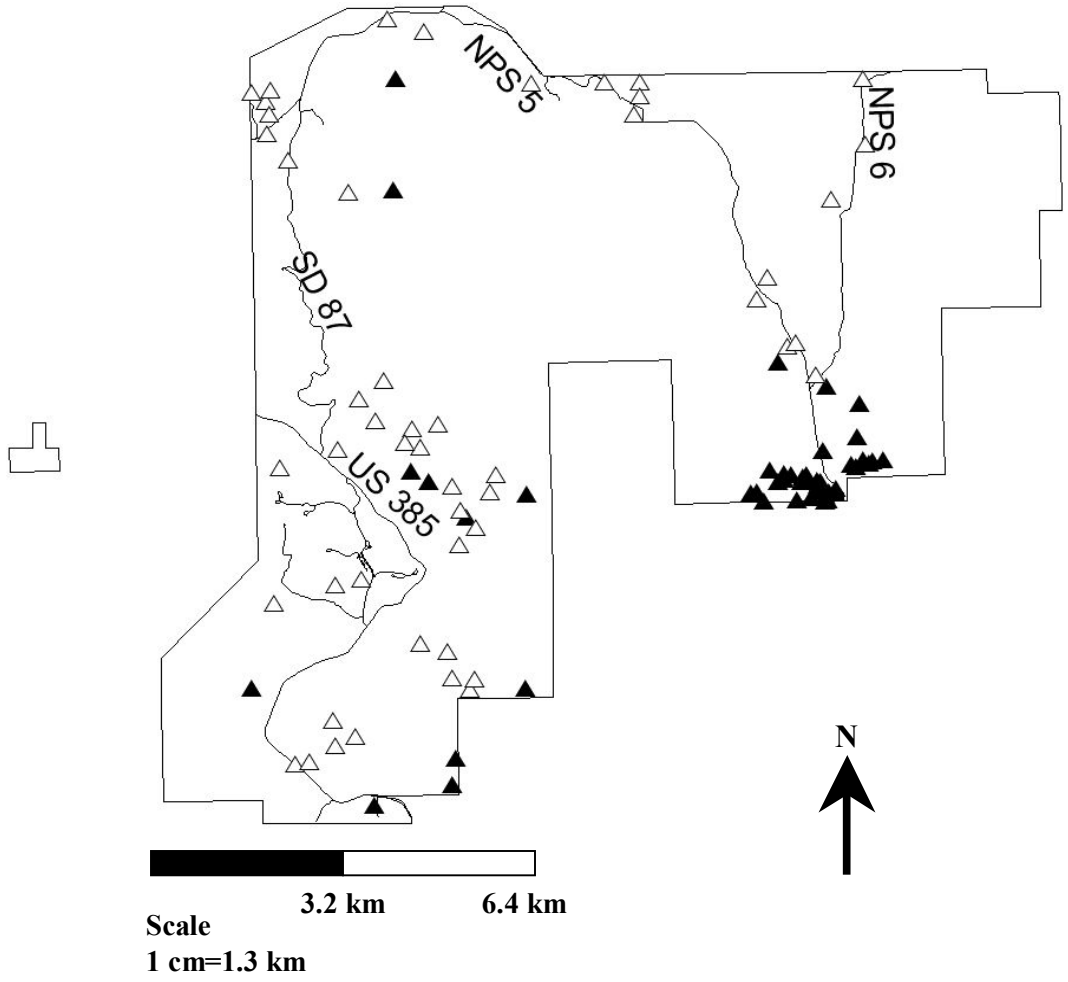


Figure 10. Regional survival of radiocollared pronghorn neonates in Wind Cave National Park, 2002-03.



△ Random site

▲ Bed site

Figure 11. Daytime bed sites (*n*=50) used by pronghorn neonates and random sites (*n*=50) in Wind Cave National Park, 2002-03.

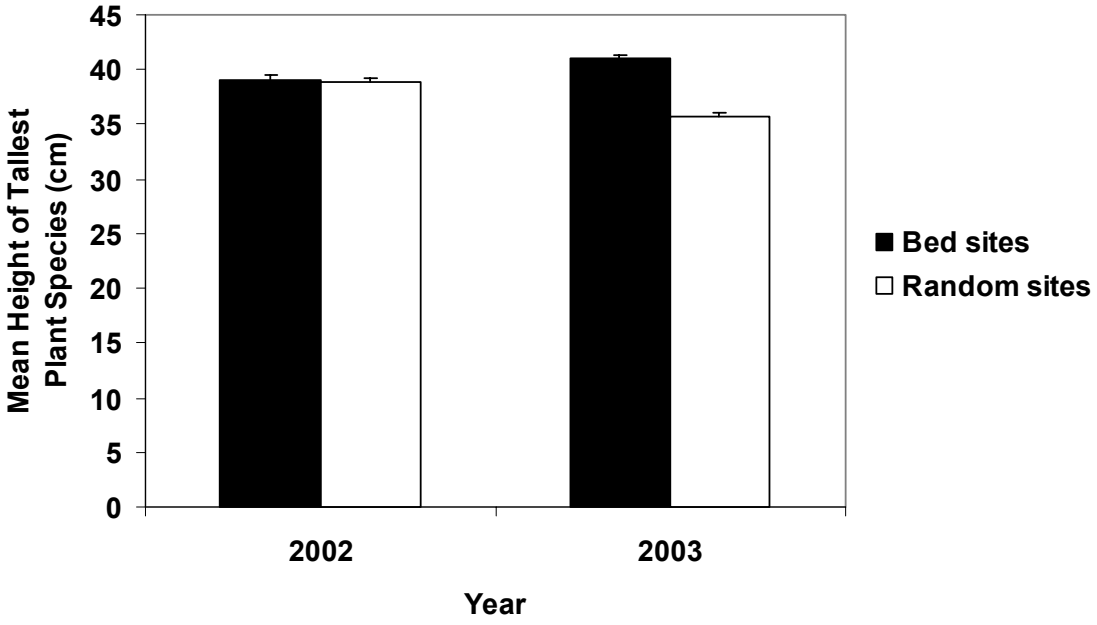


Figure 12. Height of vegetation at daytime bed sites (*n*=50) and random sites (*n*=50) for pronghorn neonates in Wind Cave National Park, 2002-03.

CHAPTER 4

DIET COMPOSTION OF PRONGHORN IN WIND CAVE NATIONAL PARK

INTRODUCTION

Food habits of pronghorn have been studied with respect to forage items consumed and competition with other ruminants. Sagebrush (*Artemisia species*) has been identified in several studies as an important food item in pronghorn diets (Mason 1952, Mitchell and Smoliak 1971, Messenger and Schitoskey 1980). Changes in sagebrush density could affect overall health of pronghorn herds. A decrease in the quality of sagebrush in pronghorn diets can cause poor body condition and fawn mortality in winter months (Bayless 1969). There is some evidence to suggest that pronghorn may meet daily water requirements through consumption of moist forbs and shrubs such as sagebrush (Beale and Smith 1970).

Competition between pronghorn and other ruminants for resources may not significantly influence pronghorn diet selection. In northeastern Colorado, competition between pronghorn and bison was minimal, as pronghorn diet selection was influenced by plant preference, abundance, and availability (Schwartz and Nagy 1976). Furthermore, Schwartz et al. (1977) reported that pronghorn were selective grazers, choosing plants higher in crude protein and lower in fiber than foods found in diets of bison. Therefore, pronghorn may occupy a niche that lessens competition with larger free-ranging ruminants.

Food habits may influence other aspects of pronghorn behavior, including spatial relationships between males and females. Within a low-density population in WCNP, males that defended territories with a high percentage of forbs and sedges during the rut

consequentially had higher reproductive success than males occupying territories with a high percentage of grasses (McDonald 1987, Maher 2000). Nutritional health of pronghorn in WCNP may provide information on the overall quality of habitat for pronghorn. In this study, food habits of pronghorn in Wind Cave National Park were examined to describe the composition of forage items consumed by pronghorn throughout the year.

METHODS

Food habits were examined for pronghorn within Wind Cave National Park through opportunistic collection of fecal samples over a 12-month period. Pellets from fresh defecations were collected each month during the study period where pronghorn groups were visually observed. Microhistological fecal analysis was performed on samples to determine coverage within each sample. The procedures of Davitt and Nelson (1980) were followed for the preparation of plant pigments for quantification and classification of pronghorn diets. Fecal samples were dried at 60° C for 48 hours, blended, and washed. Samples were then placed in a 95% ethyl-alcohol solution for 7 days to extract plant pigments and rinsed in a 40% bleach solution. Extracted plant pigments were then stored in a staining solution containing a lactophenol blue agent for 7 to 10 days. Slides of plant pigments were prepared and examined using 25 fields of view per slide to measure the area of the fragments contained within each sample (Stewart 1967). Percent coverage of each species or forage class was determined by summing the area occupied by each species and dividing by the total area contained within the slide.

Ninety-five percent confidence intervals were constructed for mean values of percent coverage for each forage class.

RESULTS

Fifty-eight fecal samples were collected between 26 January and 5 December 2002. Eleven species of grasses, 13 species of shrubs, and 3 species of forbs were identified in fecal samples (Appendix G). Pronghorn diets contained 25 plant species in winter and 20 species in summer (Table 11). Sagebrush species, including big sagebrush (*Artemisia tridentata*), fringed sagewort (*Artemisia frigida*), and silver sage (*Artemisia cana*) represented approximately 4.5% of the annual diet (Table 11). Blue grama (*Bouteloua gracilis*), common juniper (*Juniperus communis*), and northern bedstraw (*Galium boreale*) comprised 31.7% of the annual diet (Table 11). Consumption of common juniper decreased during summer months, while consumption of northern bedstraw increased during this time (Figure 13). Consumption of forbs ranged from 5 to 45% and was greater than 40% in June, August, and September (Figure 13). Shrub consumption ranged from 17 to 49% and was greater than 40% in January, February, and December (Figure 13). Grasses represented no less than 39% of food items during both summer and winter months (Figure 14). Grasses, shrubs, and forbs represented 41% ($\pm$1.8, 95% CI, SE=0.9), 30% ($\pm$2.5, 95% CI, SE=1.3), and 27% ($\pm$2.8, 95% CI, SE=1.4) of food items overall (Figure 15).

DISCUSSION

Foraging strategy of pronghorn is somewhat selective, when compared to some larger North American herbivores. Studies of pronghorn in Alberta, Canada, showed forb and shrub species were preferred over grasses, and forbs were most preferred overall (Mitchell and Smoliak 1971). Less is known about food selection in habitats similar to WCNP, in which the occurrence of sagebrush is limited. Selection of foods can be affected by numerous factors, including nutrient content and availability. Hanley (1982) suggested that food selection by small ungulates and ruminant digesters was influenced by a low rumen volume to body weight ratio, which is an adaptation to digestion of plants with thin cell walls (e.g., forbs and shrubs). Pronghorn distribution in Saskatchewan, Canada, was directly correlated with the occurrence of plant species (i.e., shrubs and forbs) with high protein content (Dirschl 1963).

Climatic changes can influence diet selection as well. Smith and Malechek (1974) reported that pronghorns in Utah maintained nutritional health even when plant species decreased in crude protein and digestibility during summer months. Drought and wet cycles affect availability of forage, and forbs are typically most readily available in spring and decrease in abundance through autumn. Pronghorn in north-central New Mexico responded to a decreased abundance of forbs during drought years by increasing their consumption of shrubs during winter (Stephenson et al. 1985). Natural fire regimes and controlled burning can influence forage availability as well. Pronghorn in southeast Alberta used prickly pear cactus (*Opuntia polyacantha*) in burned, mixed-grass prairie during fall, late winter, and early spring (Courtney 1989).

Fecal analysis can accurately identify plant species composition within pronghorn diets and achieve results similar to rumen analysis (Schwartz and Nagy 1976, Kessler et al. 1981, Stephenson et al. 1985). Grasses were the most frequently occurring food item in pronghorn diets at any time during this study and were readily available throughout the year. High numbers of plant species identified in fecal samples reflected the diversity of plants found within WCNP. The 3 most consumed plants represented the grass, shrub, and forb categories, respectively. Blue grama was observed in pronghorn diets in high amounts throughout the year. Common juniper was an important forage item in winter, while northern bedstraw was an important forage item in summer. Pronghorn frequently consumed shrubs during winter months but switched to forbs during summer months. This seasonal shift in dietary content was likely influenced by the increased availability of forbs during the growing season. High digestibility of forbs likely benefited adult females that relied on energy reserves during lactation. Shrub species, including common juniper, were utilized by pronghorn during winter months, when forbs were less abundant.

The percentage of grasses, shrubs, and forbs in the annual diets of pronghorn in WCNP differed from that of other pronghorn populations across western North America. Diet composition of pronghorn in western South Dakota (Messenger and Schitoskey 1980), north-central New Mexico (Stephenson et al. 1985), and Saskatchewan, Canada (Dirschl 1963) contained less than 17% grasses and greater than 45% shrubs annually. While the geographic distribution of sagebrush in South Dakota is limited (Knick et al. 2003), some pronghorn populations are able to consume large amounts of sagebrush.

Sagebrush species, including big sagebrush, fringed sagewort, white sage (*Artemisia ludoviciana*), and silver sage, represented greater than 5% of pronghorn diets during every month of the year in Harding County, South Dakota (Messenger and Schitoskey 1980). However, sagebrush may not be widely distributed in WCNP. Pronghorn diets in WCNP contained less than 5% big sagebrush, fringed sagewort, and silver sage during winter and summer months (Table 11). Diets of tame pronghorn on a grama-buffalo grass prairie in Colorado contained greater than 44% grasses and 43% forbs within light and heavily grazed pastures containing domestic and wild herbivores (Schwartz and Nagy 1976). Similar habitat conditions exist on grasslands in WCNP, including the presence of other wild herbivores. While consumption of grasses by pronghorn in WCNP was comparable to other populations existing within grassland dominated landscapes, the percentage of forbs consumed was less than 32% during summer months, when forbs would likely be more readily available. These findings indicated that pronghorn consumed insufficient amounts of forage (e.g., forbs and shrubs) and suggested that habitat in WCNP may not have provided pronghorn with adequate amounts of digestible forbs and shrubs. However, direct measurements of the amount of forage available to pronghorn within WCNP were not obtained during this study.

Table 11. Percent composition of pronghorn diets in Wind Cave National Park, 2002.

Species	% Diet		
	Overall	Winter	Summer
Crested wheatgrass (*Agropyron cristatum*)	1.5	tr	2.2
Redtop (*Agrostis stolonifera*)	1.1	1.2	1.0
Sideoats grama (*Bouteloua curtipendula*)	tr	tr	0.0
Blue grama (*Bouteloua gracilis*)	14.6	16.0	13.3
Smooth brome (*Bromus inermis*)	1.7	1.7	1.7
Sedge (*Carex* spp.)	tr	tr	tr
Foxtail barley (*Hordeum jubatum*)	tr	0.0	tr
Indian ricegrass (*Oryzopsis hymenoides*)	4.3	5.1	3.6
Western wheatgrass (*Pascopyrum smithii*)	tr	tr	tr
Needleandthread (*Stipa comata*)	4.8	3.9	5.7
Green needlegrass (*Stipa viridula*)	tr	tr	0.0
Unknown spp.	12.0	13.8	10.5
Total grasses	41.5	43.6	39.6
Serviceberry (*Amelanchier* spp.)	tr	tr	0.0
Silver sagebrush (*Artemisia cana*)	1.4	1.6	1.2
Fringed sagewort (*Artemisia frigida*)	2.0	3.1	1.0
Big sagebrush (*Artemisia tridentata*)	tr	tr	1.2
Bearberry (*Arctostaphylos uva-ursi*)	tr	tr	tr
Mountain mahogany (*Cercocarpus montanus*)	tr	tr	0.0

Table 11. Continued.

Species	% Diet		
	Overall	Winter	Summer
Ponderosa pine (*Pinus ponderosa*)	2.0	2.3	1.7
Wild plum, sand cherry, pin cherry chokecherry (*Prunus* spp.)	1.3	1.1	1.4
Currant (*Ribes* spp.)	2.8	1.5	3.8
Wild rose (*Rosa* spp.)	3.6	4.2	3.0
Buffaloberry (*Shepherdia* spp.)	tr	tr	0.0
Western snowberry (*Symphoricarpos occidentalis*)	3.4	4.5	2.5
Unknown spp.	2.6	2.8	2.4
Total shrubs	31.1	33.4	29.1
Sageworts (*Artemisia* spp.)	tr	0.0	tr
Aster (*Aster* spp.)	1.9	1.4	2.3
Northern bedstraw (*Galium boreale*)	6.5	6.9	6.2
Unknown spp.	18.6	14.6	22.1
Total forbs	27.4	23.0	31.3

[a]tr=trace (< 1% of diet)

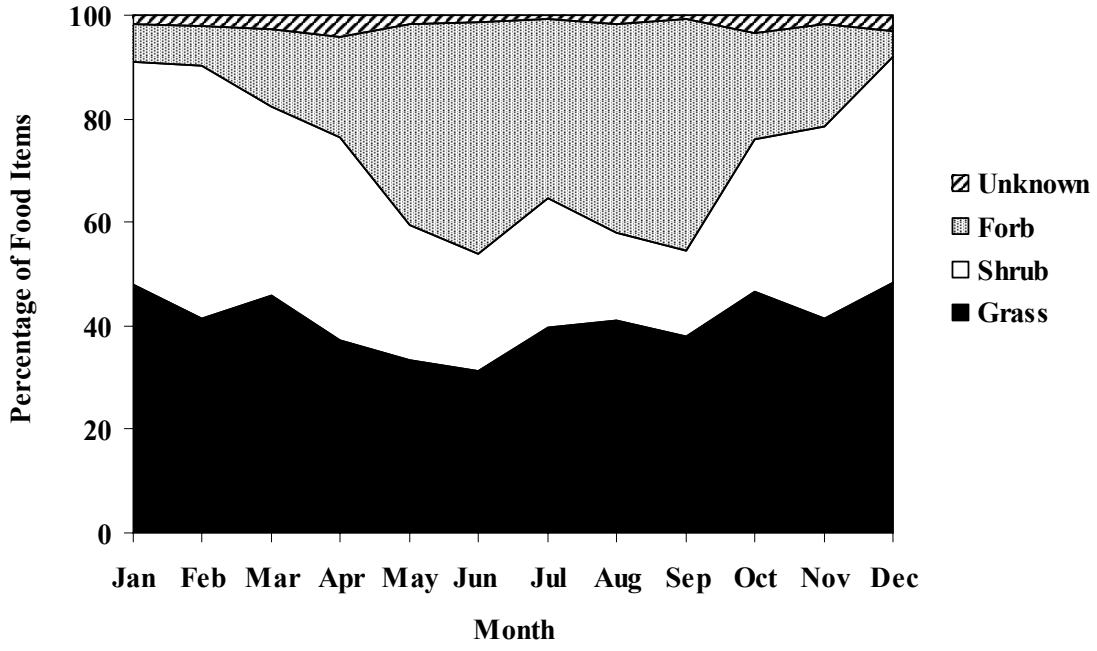


Figure 13. Monthly percentage of grass, shrub, forb, and unknown food items found in pronghorn diets (*n*=58) in Wind Cave National Park, 2002.

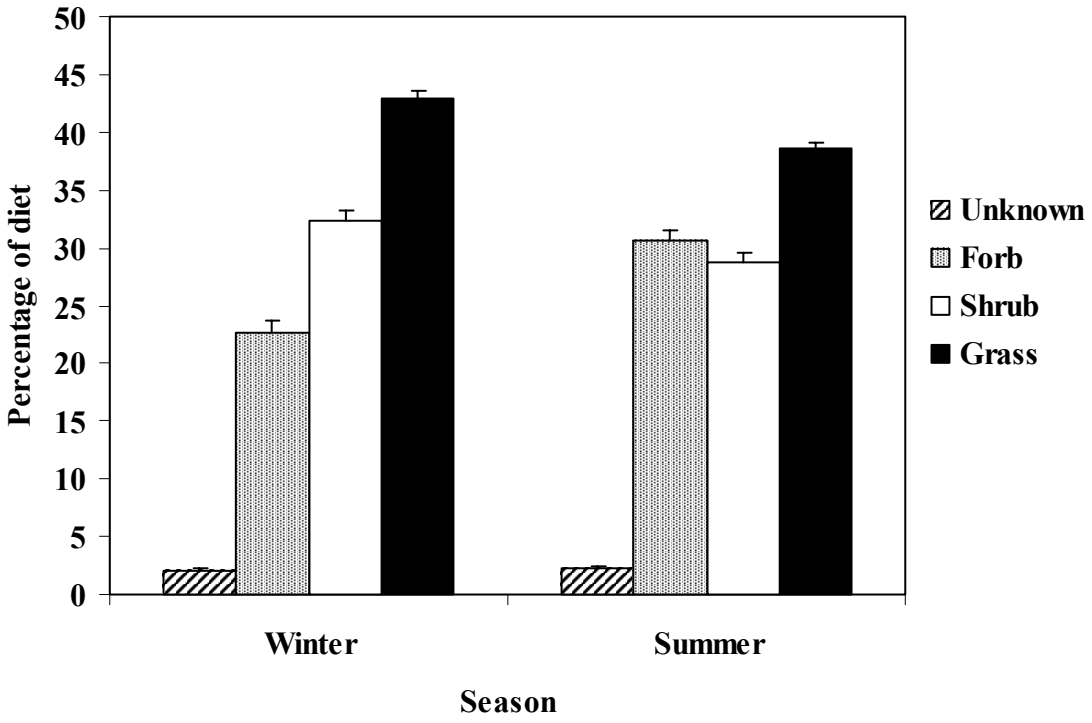


Figure 14. Percentage of grass, shrub, forb, and unknown food items found in pronghorn diets (*n*=58) during summer and winter in Wind Cave National Park, 2002.

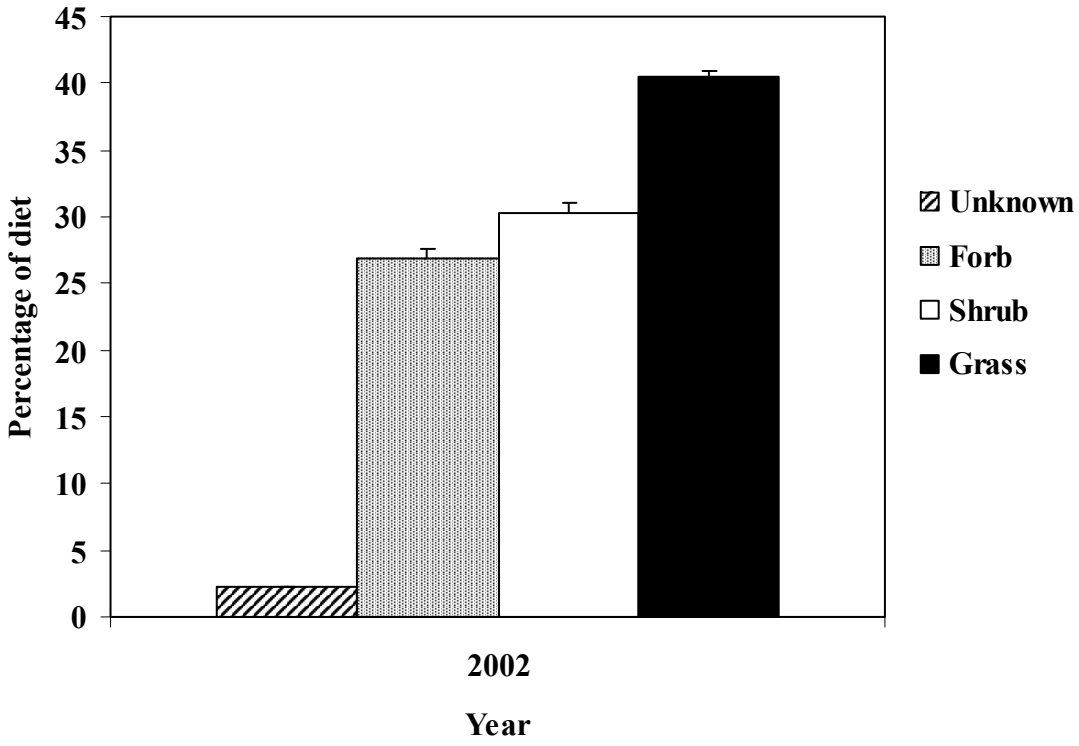


Figure 15. Annual percentage of grass, shrub, forb, and unknown food items found in pronghorn diets (*n*=58) in Wind Cave National Park, 2002.

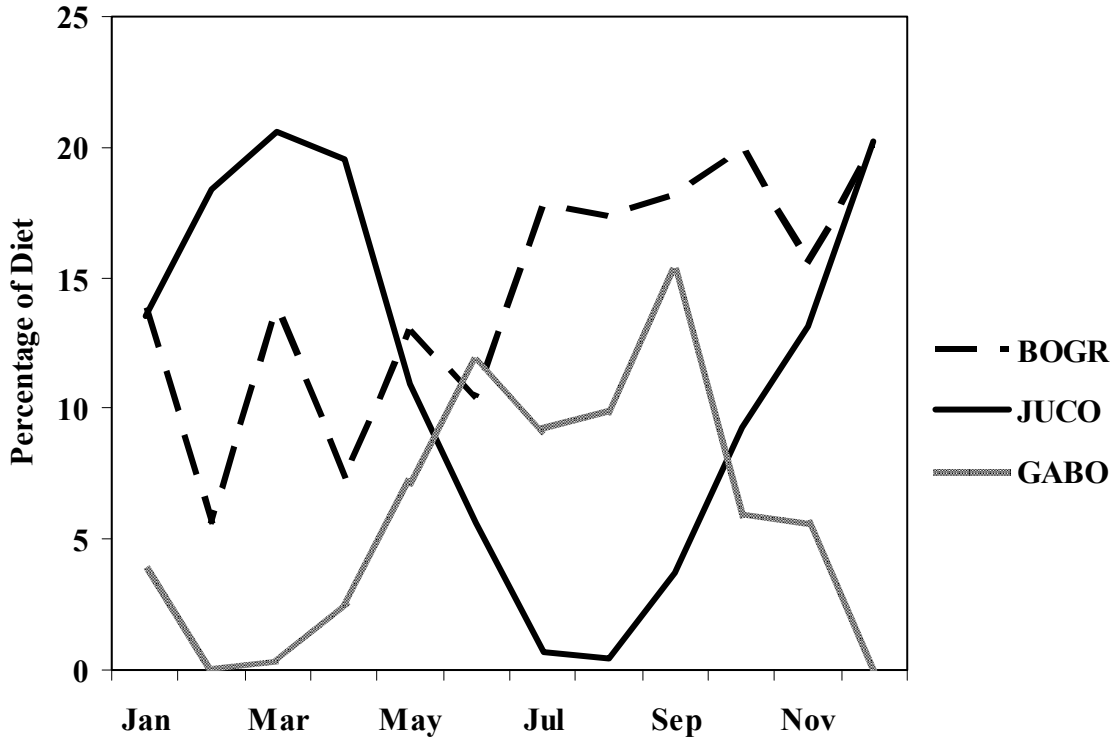


Figure 16. Monthly percentage of blue grama (BOGR), common juniper (JUCO), and northern bedstraw (GABO) found in pronghorn diets in Wind Cave National Park, 2002.

CHAPTER 5

GENETIC ANALYSIS OF PRONGHORN IN WIND CAVE NATIONAL PARK

INTRODUCTION

Analyses of genetic variation and been documented for pronghorn across its range. Pronghorn have exhibited a reduced amount of mitochondrial DNA variation compared to other mammalian populations (Lee et al. 1994). Also, pronghorn experienced a decline throughout North America in the early 1900's. Therefore, loss of genetic variation is of great concern in reintroduced and translocated populations where founder populations are often small. However, translocated or reintroduced mammalian populations can maintain genetic variation similar to remnant populations. Estimates of genetic variation have shown that pronghorn have maintained high levels of heterozygosity following the potential bottleneck events of the early 1900's (Honeycutt 2000). Translocated populations of bighorn sheep (*Ovis canadensis*) exhibited similar genetic variation to that of native populations (Ramey et al. 2000). Moreover, variation in microsatellite and mitochondrial DNA in reintroduced populations of sea otters (*Enhydra lutris*) was comparable to that of remnant populations (Larson et al. 2002).

Past efforts have categorized pronghorn into 5 recognized subspecies; American pronghorn (*A. a. americana*, Ord 1815), Oregon pronghorn (*A. a. oregona*, Bailey 1932), Mexican pronghorn (*A. a. mexicana*, Merriam 1901), Sonoran pronghorn (*A .a. sonoriensis*, Goldman 1945), and peninsular pronghorn (*A. a. peninsularis*, Nelson 1912). This knowledge has provided a framework for studying effects of translocations and reintroductions on the preservation of genetic variation. Consideration should be given to populations that are genetically different from other populations within a region. Lee et

al. (1989) studied 6 pronghorn populations in western Texas and recommended that translocations into isolated populations be conducted only if genetic information collected revealed that both populations were similar.

Studies documenting effects of inbreeding, which include decreased fitness, lower resistance to diseases, and lower ability to adapt to changing environmental conditions, have largely been conducted on captive populations (Lacy 1997). However, less is known about how inbreeding influences wild pronghorn populations. This information could be especially important in a study of the pronghorn population in WCNP, which has been declining over the past several years. In this study, genetic variation of pronghorn in WCNP was examined to identify possible constraints on population growth.

METHODS

Blood samples were collected from adult pronghorn captured within WCNP and Harding and Fall River counties, South Dakota. Samples were refrigerated until the extraction and analysis of DNA could be conducted. Genetic analysis was conducted by an independent laboratory (Biogenetic Services Inc., Brookings, South Dakota), which identified alleles at 7 microsatellite loci within samples. Microsatellite DNA contained genetic material from both parents and thus, was a better index of heterozygosity than mitochondrial DNA (Ramey et al. 2000). Microsatellite DNA was purified from samples containing 100 µl of whole blood using a Puregene DNA isolation kit. The protocol identified by Gentra Systems, Inc. (Minneapolis, Minnesota) was followed for the purification and analysis of microsatellite DNA. Primer sequences used to identify

alleles and genotypes were obtained from a study of pronghorn on the National Bison Range, Montana, where 14 microsatellite markers were identified (Carling et al. 2003). The Genes in Populations computer program (May et al. 1992) was used to determine allele frequency, heterozygosity, and the coefficient of inbreeding (departure from the Hardy-Weinberg equilibrium).

RESULTS

Seventy-five blood samples were collected from captured pronghorn in WCNP (*n*=11), Harding County, South Dakota (*n*=33) during 2002, and in Fall River County, South Dakota (*n*=31) during 2003. Five polymorphic microsatellites (Aam2, Aam3, Aam8, T268, and T108) and 2 monomorphic microsatellites (T26, T156) were identified across all 3 populations (Table 12). To maintain consistency with other studies of genetic variation in wildlife populations, only polymorphic microsatellites were included in any further analyses.

Pronghorn in WCNP and Fall River County had 21 different alleles (mean=4.2, SE=0.993), while pronghorn in Harding County had 23 different alleles (mean=4.6, SE=1.131). Observed heterozygosity ranged from 0.473 for pronghorn in WCNP to 0.594 for pronghorn in Fall River County, and expected heterozygosity ranged from 0.504 for pronghorn in WCNP to 0.575 for pronghorn in Harding County (Table 12). Inbreeding coefficients were near or below zero in the Fall River County (F_{IS}=-0.168), WCNP (F_{IS}=0.011), and Harding County (F_{IS}=0.037) pronghorn populations (Table 12). Also, measures of population subdivision were low between WCNP and Harding County

(F_{ST}=0.028), WCNP and Fall River (F_{ST}=0.032), and Harding County and Fall River County (F_{ST}=0.015) populations (Table 13).

DISCUSSION

Genetic variation can be influenced by a small number of founders, significant declines in population size, isolation by geographic features (e.g., mountain ridges) or human-induced barriers (e.g., fences, fragmented landscapes). While many of these factors existed at some time for pronghorn in WCNP, the results of this genetic analysis did not reflect values of known bottleneck populations. Also, multi-locus heterozygosity and inbreeding coefficients for pronghorn in WCNP were similar to free-ranging pronghorn populations in western South Dakota.

Analyses conducted during this study showed polymorphism in 5 of 7 microsatellites (71%). Pronghorn in the National Bison Range, Montana, showed at least 8 of 14 microsatellites to be polymorphic (Carling et al. 2003). Fewer microsatellites were observed to be polymorphic in this study. It is not known why a fewer number of microsatellites were observed in pronghorn populations in western South Dakota, when compared to pronghorn in other western states. However, the number of polymorphic microsatellites identified was consistent across all populations of pronghorn in this study. This would seem logical as pronghorn were reintroduced throughout much of its current range in South Dakota. Therefore, any genetic comparisons with other states or geographic regions would likely be applicable to populations included in this study.

Microsatellite analysis has been used to compare heterozygosity between translocated and native populations of pronghorn (Carling et al. 2003), bighorn sheep (Ramey et al. 1995), and grizzly bears (*Ursus arctos*) (Craighead et al. 1995). Radiocollared pronghorn in WCNP maintained a high level of genetic diversity, even at a reduced population size. Given that radiocollared pronghorn were able to move into and out of the park, it is likely that the same opportunities for movement existed for pronghorn inhabiting grasslands around WCNP. Also, few adult males were identified in WCNP during our study. Therefore, contributions from nonresident pronghorn to reproduction would be expected to have a significant influence on the genetic composition of the population.

Multi-locus heterozygosity values and allele frequencies obtained in this study were higher than what has been reported for populations of elk in Pennsylvania and California (mean number of alleles=1.8, 1.9; observed heterozygosity=0.222, 0.220; expected heterozygosity=0.254, 0.219) and moose (*Alces alces*) (mean number of alleles=2.6; observed heterozygosity=0.219; expected heterozygosity=0.296) that have undergone known genetic bottlenecks (Broders et al. 1999, Williams et al. 2002, Williams et al. 2004). Overall, genetic variation of pronghorn in WCNP did not limit population growth.

Table 12. Summary of microsatellite DNA data for pronghorn from 3 locations in South Dakota: number of alleles (A), observed heterozygosity (H_O), expected heterozygosity (H_E), departure from Hardy-Weinberg equilibrium, inbreeding coefficient (F_{IS}).

			Locus							Polymorphic
Population	Parameters	*n*	Aam2	Aam3	Aam8	T268	T108	T26	T156	loci
Wind Cave		11								
National Park	A		6	7	5	1	2	1	1	21
	H_O		0.727	0.455	0.182[a]	0.000	0.500	0.000	0.000	0.473
	H_E		0.698	0.818	0.504	0.000	0.500	0.000	0.000	0.504
	F_{IS}		-0.041	0.444	0.639		-1.000			0.011
Harding County		33								
	A		6	9	4	2	2	1	1	23
	H_O		0.636[a]	0.424[a]	0.364[a]	0.061	0.970[a]	0.000	0.000	0.491
	H_E		0.777	0.819	0.719	0.059	0.500	0.000	0.000	0.575
	F_{IS}		0.181	0.482	0.495	-0.031	-0.941			0.037

Table 12. Continued.

Population	Parameters	*n*	Locus							Polymorphic loci
			Aam2	Aam3	Aam8	T268	T108	T26	T156	
Fall River County		31								
	A		6	7	5	1	2	1	1	21
	H_O		0.581	0.581[a]	0.871[a]	0.000	0.935[a]	0.000	0.000	0.594
	H_E		0.703	0.764	0.721	0.000	0.498	0.000	0.000	0.537
	F_{IS}		0.175	0.240	-0.209		-0.879			-0.168
Over all populations										
	Total A		6	10	6	2	2	1	1	26
	Mean H_O		0.648	0.486	0.472	0.020	0.968	0.000	0.000	0.519
	Mean H_E		0.726	0.800	0.648	0.020	0.499	0.000	0.000	0.539

[a]Chi-square analysis showed significant differences between observed and expected allele frequencies at $p<0.05$.

Blank cell represents "no data."

Table 13. Tests for population subdivision (F_{ST}) between pronghorn populations from 3 locations in South Dakota, 2002-03.

F_{ST}	Harding County	Fall River County
Wind Cave National Park	0.028[a]	0.032[a]
Fall River County	0.015[a]	—

[a]Values calculated using Genes in Populations program.

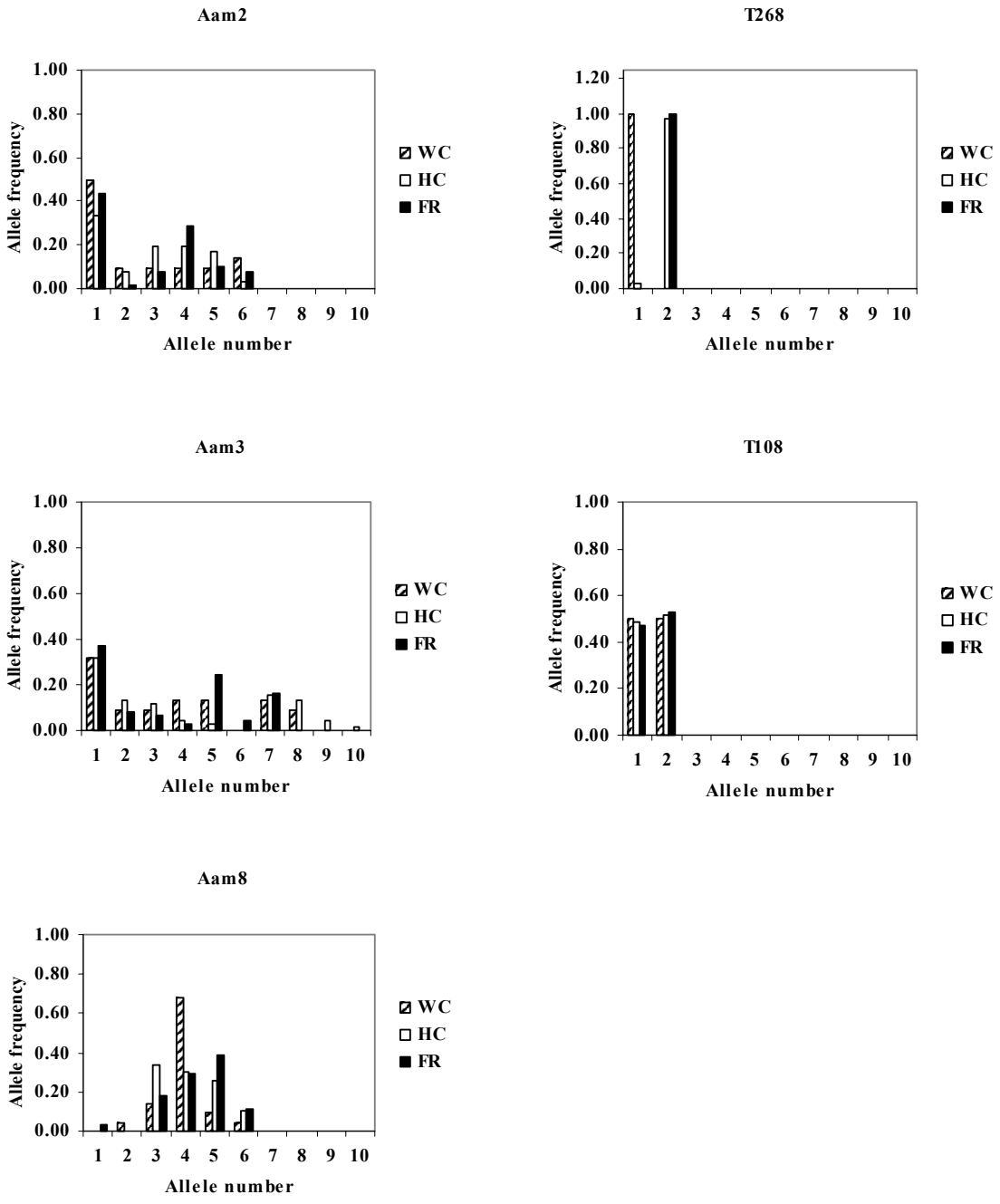


Figure 17. Allele frequencies at five microsatellites typed in all samples (*n*=75) of pronghorn in Wind Cave National Park (WC), Harding County (HC), and Fall River County (FR), South Dakota, 2002-03.

CHAPTER 6

MANAGEMENT IMPLICATIONS

No direct information was available on mortality and movements of pronghorn in WCNP before 2002. Findings of this study supported previous research, which suggested that pronghorn populations are vulnerable to predation and low survival rates of neonates (Ch. 3). Predator-related mortality was the primary factor affecting pronghorn neonates in WCNP. Direct information on predator densities in WCNP is currently being collected. The outbreak of mange in the coyote population in WCNP in 2003 and 2004 may continue to influence the pronghorn population in the near future. Increasing fawn recruitment resulted in an overall increase in the population during this study (Appendix H). Adult female pronghorn had high survival (Ch. 3) and were often able to escape predators. Older-aged adults or adult females caring for young were more vulnerable to death by predation than other adults.

This study identified height of vegetation and plant species composition as important criteria in the selection of bed sites (Ch. 3). Bromley (1977) had identified the importance of bare depressions of exposed soil for the immediate bed site. Bed site selection by pronghorn neonates in WCNP was closely associated with landscape features that provided protection from predators while allowing for visibility by adult females.

Historic records indicated that pronghorn had opportunities during winter months to move out of the park, but the rate and frequency of these movements was not fully understood. Two adult females moved out of WCNP for a short period during this study by going underneath the boundary fence (Ch. 2). An adult male that moved into WCNP may have done so by the same method. Snow cover was not deep enough during winter

months to allow movement of pronghorn over cattle guards or to contribute to winter mortality. Therefore, it could not be determined if movement and mortality during severe winters contributed to significant losses of pronghorn.

Diet composition of pronghorn was influenced by the availability of plant species that occurred in the mixed-grass prairie of WCNP. Grass consumption was consistently high throughout the year. Shrubs were an important food item during winter months, and forbs were an important food item during summer months. Pronghorn in WCNP were able to adapt to seasonal changes in food availability by shifting to plants that were readily available (Ch. 4). Annual diets of pronghorn in WCNP may not have contained sufficient amounts of forbs and shrubs, when compared to the diets of pronghorn in sagebrush-dominated habitats across western North America. Numerous stresses existed for pronghorn in WCNP (e.g., predation, restricted movement), and the amounts of forage available may not have been sufficient for maximizing individual fitness or allowing population increase of pronghorn in WCNP.

Genetic analyses of pronghorn in isolated and free-ranging populations in western South Dakota showed similar levels of genetic variation. Observed heterozygosity in pronghorn within WCNP was similar to free ranging populations in western South Dakota (Ch. 5). Genetic variation of all pronghorn populations in western South Dakota was not consistent with other ungulate populations that had undergone known bottlenecks, indicating that genetic variation of pronghorn in WCNP was likely not limiting population growth. Additionally, characteristics of inbreeding depression that have been documented for mammalian populations (e.g., reduction in fertility, individual

fitness, growth, and development) (Honeycutt 2000) were not observed in pronghorn in WCNP during this study.

This study was designed to identify factors contributing to the decline of the pronghorn population in Wind Cave National Park, South Dakota. To accomplish this, aspects of pronghorn ecology that have been identified by previous studies as significant sources of loss or mortality were examined. Movement patterns did not contribute to a large number of losses or deaths during this study. Also, genetic variation did not contribute directly to mortality in pronghorn through reduced individual fitness or reproductive effort. However, the effects of a genetic bottleneck would be more easily observed through a long-term study of the pronghorn population in WCNP. Additionally, direct study of reproductive effort in breeding females would provide information on individual fitness, as it relates to genetic variation and the overall quality of the habitat in WCNP. Annual diets of pronghorn in WCNP indicated the amounts of forbs and shrubs that were consumed were less than the amount of grasses consumed. Further study of the vegetation would likely determine if differences in habitat quality between WCNP and areas where other pronghorn populations exist in the presence of a high-density predator population. An evaluation of habitat also would allow decisions to be made as to whether pronghorn can be maintained inside the park and at what densities. Any natural increase in the pronghorn population may depend upon a decrease in the density of predators or other ungulates within the park. Pronghorn and predator populations must continue to be observed so that information on survival rates, movement patterns, and population densities can be collected. This information will provide the basis for developing sound

management decisions for pronghorn in WCNP, South Dakota in the future. While removal of coyotes may result in short-term increases in pronghorn numbers, only the presence of quality habitat after predator control activities have ceased will likely allow pronghorn populations to increase over the long-term (Phillips and White 2003).

Forage consumption by pronghorn and neonate survival were likely factors limiting growth of the pronghorn population in WCNP. Predation on pronghorn neonates accounted for a significant number of deaths. Also, results of forage consumption by pronghorn during this study suggested that the availability of forb and shrub components within WCNP may be lacking. Comparisons of the distribution of pronghorn during the early 1970's (Bromley 1977) with the distribution of pronghorn during this study (Ch. 2) suggested that significant differences in the composition of vegetation may exist. The Bison Flats region of WCNP was used extensively by pronghorn during the 1970's but was used sparingly by pronghorn during this study. Additionally, territories that were established by several adult males during previous years (Bromley 1977) supported 1 adult male during this study. However, direct measurements of vegetation were not taken and conclusions could not be made without direct study of forage availability. Habitat evaluations (e.g., percent coverage and density of forbs and shrubs) could provide further information about the availability of forage in WCNP. Habitat suitability models have been developed for assessing quality of habitat within pronghorn ranges using measurements of vegetation (e.g., plant height, cover, diversity) (Cook and Irwin 1985). Such models could provide critical information about the suitability of habitat that exists for pronghorn in WCNP.

Management practices (e.g., controlled burning programs) should strive to maintain the amount of forage (e.g., sagebrush) available for pronghorn throughout the year. The response of sagebrush to current management practices should be evaluated. Prescribed fires, mechanical treatments, biological agents, and herbicides have been associated with declines in sagebrush density within western states (Connelly et al. 2000, Knick et al. 2003). Also, prescribed burning has been documented to contribute to declines in other wildlife species requiring significant amounts of sagebrush habitat. Breeding populations of sage grouse (*Centrocercus urophasianus*) in southeastern Idaho experienced severe declines following burning periods (Connelly et al. 2000). The availability of sagebrush will likely be critical to the future existence of pronghorn in WCNP. Information on forage availability and response of sagebrush to current management activities will provide the basis for future management strategies regarding the pronghorn population in Wind Cave National Park, South Dakota.

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Appendix A. Capture data of female pronghorn in Wind Cave National Park, January 2002.

Capture date	Collar frequency	Age at capture	Processing time (min)	Rectal temperature (C°)	Neck girth (cm)	Chest girth (cm)	Right rear foot length (cm)
01/23/02	151.614		12.0	38.0	18.0	111.5	35.0
01/23/02	151.674	4.5	9.0	38.5	37.0	100.5	35.0
01/23/02	151.552		8.0	40.1			
01/23/02	151.596	6.5	8.0	40.3	50.0	108.0	35.0
01/23/02	151.695	6.5	7.0	40.4	48.5	98.0	36.0
01/23/02	151.632	1.5	8.0	39.6	40.0	100.0	35.0
01/23/02	151.533	4.5	7.0	38.9	43.0	101.5	33.0
01/23/02	151.623	6.5	6.0	39.2	45.0	109.0	36.5
01/23/02	151.544	1.5	10.0	39.3	35.0	96.0	35.5
01/23/02	151.583	1.5	6.0	40.8	40.0	93.0	35.0
01/23/02	151.654	4.5	7.0	41.0	39.5	105.0	34.5

Blank cell represents "no data".

Appendix B. Movement of individual female pronghorn in Wind Cave National Park, 2002.

Collar Frequency	Summer 95% home range (km^2)	Summer 50% home range (km^2)	Winter 95% home range (km^2)	Winter 50% home range (km^2)	Largest summer movement (km)	Largest winter movement (km)
151.533	100.8	5.3	76.2	3.6	11.2	10.1
151.544	39.0	5.7	66.0	12.6	8.8	8.4
151.552	33.7	4.7	105.5	4.1	10.0	11.0
151.596	29.3	3.5	105.5	4.1	11.2	11.0
151.614	47.5	5.8	40.9	4.6	11.5	11.0
151.632	63.8	10.5	40.1	8.7	8.0	8.4
151.654	43.8	5.1	37.6	10.5	8.8	8.4
151.695	78.2	17.7	61.0	9.4	10.0	10.9

Appendix C. Capture data of pronghorn neonates in Wind Cave National Park, summer 2002.

Capture date	Collar frequency	Age at capture (weeks)	Processing time (min)	Sex	Weight (kg)	Condition of umbilicus	Hoof condition	Hoof growth measurement (mm)
06/05/02	166.015	1.0-2.0	6.0	Female	3.7	Scabbed	Hard	3.073
06/05/02	166.030[a]	<1.0	5.0	Female	3.5	Moist	Soft	2.413
06/05/02	166.055[a]	<1.0	5.0	Female	3.5	Moist	Soft	2.413
06/07/02	166.082	1.0-2.0	7.0	Female	3.3	Scabbed	Hard	1.930
06/07/02	166.104[b]	1.0-2.0	6.0	Female		Scabbed		
06/08/02	166.006[b]	1.0-2.0	5.0	Male	4.0	Scabbed	Soft	2.591
06/08/02	166.165[c]	<1.0	6.0	Female	2.8	Moist	Soft	1.778
06/08/02	166.041[c]	<1.0	6.0	Male	2.4	Moist	Soft	1.854
06/11/02	166.140	1.0-2.0	9.0	Male	3.4	Scabbed	Hard	2.489
06/11/02	166.180[d]	<1.0	6.0	Female	2.9	Moist	Soft	
06/11/02	166.064[d]	<1.0	6.0	Female	2.9	Moist	Soft	
06/10/02	166.156	1.0-2.0	7.0	Male	3.1	Scabbed	Soft	2.667
06/11/02	166.092	1.0-2.0	6.0	Male		Scabbed	Hard	2.743

[a]Indicates a fawn from a twin group.

Blank cell represents "no data".

Appendix D. Capture data of pronghorn neonates in Wind Cave National Park, summer 2003.

Capture date	Collar frequency	Age at capture (weeks)	Processing time (min)	Sex	Weight (kg)	Condition of umbilicus	Hoof condition	Hoof growth measurement (mm)
05/31/03	166.115[a]	< 1.0	4.0	Male	3.8	Moist	Soft	2.667
05/31/03	166.165[a]	< 1.0	6.0	Female	3.4	Moist	Soft	2.667
05/31/03	166.156	< 1.0	8.0	Female	2.6	Scabbed	Hard	2.997
06/02/03	166.041[b]	< 1.0	5.0	Female		Moist	Soft	
06/02/03	166.030[b]	< 1.0	5.0	Female	3.1	Moist	Soft	
06/04/03	166.055	< 1.0	8.0	Female	3.9	Moist	Hard	
06/06/03	166.104	1.0-2.0	5.0	Female	3.3	Scabbed	Soft	
06/08/03	166.015	1.0-2.0	5.0	Female	3.8	Scabbed	Hard	3.048
06/08/03	166.041[c]	1.0-2.0	5.0	Female	4.9	Scabbed	Hard	5.207
06/09/03	166.130[c]	1.0-2.0		Female		Scabbed	Hard	
06/10/03	166.092	1.0	5.0	Male		Scabbed	Hard	4.775
06/12/03	166.082	< 1.0	4.0	Male	3.5	Scabbed	Hard	2.286
07/05/03	166.092	< 1.0		Male		Moist	Soft	

[a]Indicates a fawn from a twin group.

Blank cell represents "no data".

Appendix E. Mortality of female and neonate pronghorn in Wind Cave National Park, 2002.

Capture location	Collar Frequency	Sex	Age at capture	Date of capture	Cause of death	Age at death (years)	Date of death	Location of death
Bison Flats	166.015	Female	Fawn	06/05/02	Predation	< 0.25	06/15/02	Bison Flats
Red Valley	166.030[a]	Female	Fawn	06/05/02	Predation	< 0.25	06/21/02	Red Valley
Red Valley	166.055[a]	Female	Fawn	06/05/02	Predation	< 0.25	07/01/02	Red Valley
Cold Brook Canyon	166.082	Female	Fawn	06/07/02	Predation	< 0.25	06/11/02	Cold Brook Canyon
Bison Flats	166.104[b]	Female	Fawn	06/07/02	Predation	< 0.25	06/28/02	Bison Flats
Red Valley	166.041[c]	Male	Fawn	06/08/02	Predation	< 0.25	06/17/02	Red Valley
Red Valley	166.165[c]	Female	Fawn	06/08/02	Predation	< 0.25	06/24/02	Red Valley
Bison Flats	166.006[b]	Male	Fawn	06/08/02	Predation	< 0.25	07/02/02	Bison Flats
Rankin Ridge	166.156	Male	Fawn	06/10/02	Predation	< 0.25	06/26/02	Rankin Ridge
Red Valley	166.092	Male	Fawn	06/11/02	Predation	< 0.25	06/17/02	Red Valley
Mixing Circle	151.544	Female	Adult	01/23/02	Predation	5.5	12/08/02	Lone Pine Lookout
Mixing Circle	151.583	Female	Adult	01/23/02	Capture injury	1.5	01/23/02	Mixing Circle
Red Valley	151.623	Female	Adult	01/23/02	Capture injury	6.5	01/23/02	Red Valley
Mixing Circle	151.674	Female	Adult	01/23/02	Capture injury	4.5	01/30/02	Red Valley

Appendix F. Mortality of female and neonate pronghorn in Wind Cave National Park, 2003.

Capture location	Collar Frequency	Sex	Age at capture	Date of capture	Cause of death	Age at death (years)	Date of death	Location of death
Red Valley	166.156	Female	Fawn	05/31/03	Starvation	< 0.25	06/06/03	Red Valley
Prairie Dog Canyon	166.165[a]	Female	Fawn	05/31/03	Predation	< 0.25	06/10/03	Prairie Dog Canyon
Prairie Dog Canyon	166.115[a]	Male	Fawn	05/31/03	Predation	< 0.25	06/20/03	Prairie Dog Canyon
Red Valley	166.041[b]	Female	Fawn	06/02/03	Capture	< 0.25	06/07/03	Red Valley
Bison Flats	166.055	Female	Fawn	06/04/03	Predation	< 0.25	06/19/03	Gobbler Pass
Red Valley	166.104	Female	Fawn	06/06/03	Predation	< 0.25	07/10/03	Red Valley
Red Valley	166.015	Male	Fawn	06/08/03	Predation	< 0.25	07/02/03	Red Valley
Red Valley	166.092	Male	Fawn	06/10/03	Capture	< 0.25	06/11/03	Red Valley
Red Valley	166.082	Male	Fawn	06/12/03	Predation*	0.25	08/30/03	Red Valley
Mixing Circle	151.552	Female	Adult	01/23/02	Predation		07/08/03	Red Valley

[a]Indicates a fawn from a twin group.

*Fawn was more than 45 days old when mortality occurred.

Blank cell represents "no data".

Appendix G. Plant species identified in pronghorn fecal samples collected in Wind Cave National Park, 2002.

Common name	Scientific name[a]	Acronym
Grasses		
Crested wheatgrass	*Agropyron cristatum*	AGCR
Redtop	*Agrostis stolonifera*	AGST
Sideoats grama	*Bouteloua curtipendula*	BOCU
Blue grama	*Bouteloua gracilis*	BOGR
Smooth brome	*Bromus inermis*	BRIN
Sedge spp.	*Carex* spp.	CAREX
Foxtail barley	*Hordeum jubatum*	HOJU
Indian ricegrass	*Oryzopsis hymenoides*	ORHY
Western wheatgrass	*Pascopyrum smithii*	PASM
Needleandthread	*Stipa comata*	STCO
Green needlegrass	*Stipa viridula*	STVI
Shrubs		
Serviceberry spp.	*Amelanchier* spp.	AM
Silver sagebrush	*Artemisia cana*	ARCA
Fringed sagewort	*Artemisia frigida*	ARFR
Big sagebrush	*Artemisia tridentata*	ARTR
Bearberry	*Arctostaphylos uva-ursi*	ARUV
Mountain mahogany	*Cercocarpus montanus*	CEMO
Common juniper	*Juniperus communis*	JUCO
Ponderosa pine	*Pinus ponderosa*	PIPO
Wild plum, Sand cherry, Chokecherry	*Prunus* spp.	PRUNUS
Currant spp.	*Ribes* spp.	RIBES
Wild rose spp.	*Rosa* spp.	ROSA
Buffaloberry spp.	*Shepherdia* spp.	SHEP
Western snowberry	*Symphoricarpos occidentalis*	SYOC
Forbs		
Sageworts and Wormwoods	*Artemisia* spp.	ARTEMISIA
Aster spp.	*Aster* spp.	ASTER
Northern bedstraw	*Galium boreale*	GABO

[a]Scientific names in accordance with Larson and Johnson 1999.

Appendix H. The Wind Cave National Park pronghorn population.

	Adults at beginning of year			Fawns alive in October				
Year	Males	Females	Total	Males	Females	Total	Introductions	Mortalities and removals
2002	3	20	23	3	5	8		11, predation; 3, capture-related 2, status unknown
2003	6	23	29	1	3	4[a]	1 adult male, origin unknown	7, predation; 1, starvation 2, capture-related
2004	8	36	44				10 fawns	

[a]Includes radio-collared fawns only.

Blank cell represents "no data".